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MEXICO'S OIL AND GAS POLICY: AN ANALYSIS

PREPARED FOR THE

COMMITTEE ON FOREIGN RELATIONS
UNITED STATES SENATE

AND THE

JOINT ECONOMIC COMMITTEE
CONGRESS OF THE UNITED STATES

BY

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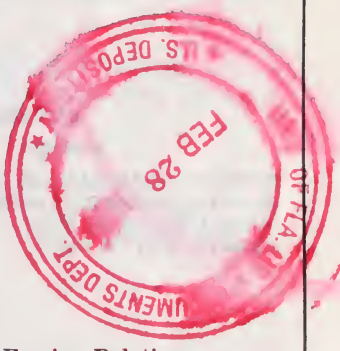

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LETTERS OF TRANSMITTAL

JUNE 30, 1978.

Mr. GILBERT GUDE,
Director, Congressional Research Service,
Library of Congress,
Washington, D.C.

DEAR MR. GUDE: The Senate Foreign Relations Committee's Subcommittee on Foreign Economic Policy has long recognized the critical importance of adequate crude oil and other energy supplies to the well-being of the economy of the United States. Because large-scale supplies of crude oil will come increasingly from non-U.S. sources, the nature and extent of a producing country's crude oil and natural gas resources will be a critical factor, among others, in our foreign relations with that country. The relative availability of oil supplies throughout the world will weigh heavily in our energy planning.

I would appreciate it if the Congressional Research Service could report on one of the most significant new sources of hydrocarbon supplies—Mexico. This report would analyze Mexico's present and projected rates of oil and gas production. It should describe the technical and economic factors affecting the pace and extent of oil and gas development.

An objective assessment by the CRS of Mexico's hydrocarbon potential could aid the Subcommittee in its ongoing evaluation of world oil supplies.

Thank you for your help in this matter.

Sincerely,

FRANK CHURCH, *Chairman,*
Subcommittee on Foreign Economic Policy.

CONGRESS OF THE UNITED STATES,
JOINT ECONOMIC COMMITTEE,
Washington, D.C., June 26, 1978.

Mr. GILBERT GUDE,
Director, Congressional Research Service,
Library of Congress,
Washington, D.C.

DEAR MR. GUDE: On March 21, the Joint Economic Committee's Subcommittee on Energy concluded three days of hearings on international energy supplies. A number of our witnesses emphasized the critical importance of Mexico in the next decade. One witness, Dr. Bernardo Grossling, spoke of Mexico as another Saudi Arabia. His estimates are optimistic and others are of a different view. Moreover, the Mexican National Oil Company recently announced that it was going to hold its production at the level projected for 1980 in spite of recent additions which tripled its oil reserve.

I would appreciate it if the Congressional Research Service would complete for me a paper which focuses on the size of the Mexican reserve, as best as we can tell, but particularly discuss the issues involved in Mexico's decision as to what level of production it wishes to reach in 1985 to 1990.

For example, is Mexico constrained by a shortage of capital, manpower, technology or equipment? Most important, what are the political influences at play and what economic conditions would cause Mexico to seek the maximum production? I am particularly interested in having your staff look carefully at what political leaders in Mexico are saying and what conclusions one can reach by reading the Mexican press and reports within the country.

It would be helpful if some of these documents, whether in English or Spanish, are made available to me. If you have additional questions about this request, I suggest you talk to Jerry Brady of the Joint Economic Committee staff. I appreciate this assistance and the help you have given me in the past.

Sincerely,

EDWARD M. KENNEDY.

THE LIBRARY OF CONGRESS,
CONGRESSIONAL RESEARCH SERVICE,
Washington, D.C., December 31, 1978.

Hon. EDWARD M. KENNEDY, *Chairman,*
Energy Subcommittee, Joint Economic Committee,
Hon. FRANK CHURCH, *Chairman,*
Foreign Economic Policy Subcommittee,
Committee on Foreign Relations,
U.S. Senate, Washington, D.C.

DEAR SENATOR KENNEDY AND SENATOR CHURCH: In response to your requests, we are submitting our final report on Mexico's oil and gas policy for the period 1978 to 1988. The report provides an analysis of Mexico's oil and gas development plans and their probable effect on Mexico. Also provided is an analysis of the probable impact that Mexico's oil and gas plans will have on United States energy policy and on overall United States-Mexican relations.

This study was coordinated by Gary J. Pagliano, Analyst in Energy Policy (Environment and Natural Resources Division), who also prepared several sections of the report. The other authors included Alvin Kaufman, Senior Specialist in Mineral and Regulatory Economics (Senior Specialist Division); David M. Lindahl, Analyst in Energy Policy (Environment and Natural Resources Division); Joseph P. Riva, Specialist in Earth Science (Science Policy Division); Barry A. Sklar, Specialist in Latin American Affairs (Foreign Affairs and National Defense Division); and Susan J. Bodilly, Research Assistant in Mineral and Regulatory Economics (Senior Specialist Division).

We hope that this report will serve the needs of your Committees as well as those of other committees and Members of Congress.

Sincerely,

GILBERT GUDE,
Director.

FOREWORD

By Senator Frank Church

The discovery of new energy supplies in Mexico is a significant and important event. It should focus, at long last, attention on a serious reexamination of U.S. relations with our Latin American neighbors and on a reassessment of our energy planning. For too many years, we have not paid enough attention to developing healthy relationships with these countries. In the case of United States-Mexican relations, the task must be viewed as a serious and comprehensive effort to resolve the hard issues which confront us today. Energy is only part of the agenda. Such matters as trade, technology transfer, immigration, border industry, and illegal drug traffic must also be faced squarely and intelligently by both nations.

By the end of the next decade, physical limitations on the oil supply could arbitrarily and abruptly limit the amount of oil available to fuel our cars, our homes, and our economy. The day of an energy reckoning is close at hand. We cannot expect increased oil production from OPEC to keep pace with rising demands, especially since the large producing countries, such as Saudi Arabia and Iran, are unlikely or unable to expand substantially present capacity. Unless we plan now to curb oil demand in an orderly and rational manner, a competitive and divisive political struggle for oil between consuming nations could develop. In this context, the Mexican discoveries have come at a propitious moment.

I believe that it is important that the public have accurate information about the new Mexican oil discoveries. It was for this reason that I requested that the Congressional Research Service undertake a comprehensive study on Mexican oil discoveries. The CRS report which follows is important because it reveals two very significant findings concerning the Mexican oil situation. First, Mexico has the proven reserves to be a significant oil and gas producer over the next few years. Second, unless the United States buys Mexican gas, Mexican oil production will be limited. Because of the large volumes of natural gas mixed with the oil, Mexico cannot produce oil without also producing a large quantity of natural gas.

Mexico's current proven reserves of 40 billion barrels are adequate to support an oil production rate of 3.6 to 4,8 million barrles a day, far above current production levels. If the additional reserves found in the more speculative category of "probable reserves" are proven to exist, these rates could be doubled. However, future production will be determined by two basic considerations: Mexico's perception of its ability to put to constructive use the oil revenues, and its ability to use domestically or sell internationally the natural gas produced in association with the oil.

All decisions about Mexican economic development, including oil and gas development, are matters of Mexican sovereignty. The President of Mexico, José Lopez Portillo, in his recent State of the Union address, called for projects which will expand the present infrastructure, raise the standard of living of Mexicans, and promote industrial and rural development. In view of the level of expenditures required to attain these targets, it is likely that Mexico will wish to develop and produce its petroleum resources as rapidly as prudent.

We do not know whether any steps that the United States takes with regard to Mexico can help to eliminate the constraints on additional Mexican oil production. However, the report identifies one area in which U.S. oil policy is in the unenviable position of standing in the way of future production increases of oil and gas that Mexico may desire. Mexico—despite its attempts—cannot profitably use all the natural gas it produces in association with the crude oil, once it reaches oil production rates above 3 million barrels a day. Unless Mexico signs an agreement to export gas to the United States, its only profitable market, oil production will be slowed by 1983. We cannot wait until 1983 to sign a natural gas contract. Mexico must soon make decisions about the size and direction of future Mexican gas and oil production. We should be aware that failure to purchase natural gas could force Mexico to adopt a strategy stressing slower oil production.

Mexican oil will not be a panacea to our energy problems. Rather, the Mexican discoveries buy consuming nations the time needed to curb their growing appetites for oil and to make less disruptive the conversion to more abundant energy sources, such as nuclear fuel. The prolific gas potential in Mexico coupled with the recent natural gas discoveries in Canada, existing large Alaskan gas reserves, and promising gas finds in the Arctic waters of the Beaufort Sea, suggest that the United States should give serious consideration to also using natural gas as a replacement for dwindling oil supplies.

The energy question, as this report clearly demonstrates, will be a major foreign policy issue facing us in the coming years. Therefore, I will ask the Senate Foreign Relations Committee to give serious consideration to the issues of international energy and United States-Mexican relations in the coming year.

FOREWORD BY SENATOR EDWARD M. KENNEDY

Nine months ago, during March 21 hearings of the Subcommittee on Energy, I asked Dr. Bernard Grossling, a scientist at the U.S. Geological Survey, about the size of the Mexican reserve. The proven reserve stood at 17 billion barrels, he said, but ". . . . the total possible growth is 20 times that amount. This could be even larger."

If Dr. Grossling's astonishing 340-billion-barrel estimate—or anything approaching that figure—were accurate, it seemed to me the energy and foreign policies of the United States would be profoundly altered. It was to verify the accuracy of Dr. Grossling's report and, more important, to alert the Congress to the importance of Mexico that I requested this report.

Today, this study is released in an atmosphere of intense interest in Mexico. Not a day goes by without news of fresh discoveries, speculation about the eventual level of Mexican oil and gas exports or another analysis of impact of this new wealth of Mexico and the United States. The report is, thus, extraordinarily timely since it addresses all three of these concerns. It is the most complete and detailed analysis by a governmental source available today.

OIL PRODUCTION AND GAS EXPORTS

Those who expect that Mexico will relieve the United States of its basic obligation—which is to conserve energy—will be disappointed by the report's estimate that, by 1988, Mexico will produce 3.8 million barrels of oil a day. Recent reports from the administration speak of 5 million barrels per day by 1985. The Library's figures are consistent with the most recent statements by the President of Mexico, José Lopez Portillo, emphasizing that Mexico will produce no more oil than is necessary to meet its own developmental needs without stimulating inflation.

This report is extremely valuable to understanding the importance of a gas agreement to maximum oil production. The study indicates that unless Mexico can export gas, it will have to shut in at least 800,000 barrels of oil per day by 1988 and much larger volumes thereafter because oil is found in association with gas and must be reinjected, flared, consumed domestically, or exported. This source of oil, so close to our market, so much more secure and—according to the study—somewhat less expensive for American consumers over time, should be welcomed into the American market. But even if Mexico sold not one drop of that oil to the United States, it is clearly in our interest to augment world supplies from non-OPEC sources and to shift the world's—if not the United States'—reliance away from the Middle East.

Gas exports are also important for Mexican economic development. The study indicates that maximum oil production (made possible by

gas exports) plus gas sales would increase the gross domestic product of Mexico by 5 percent, increase employment by 4 percent and *reduce* inflation, compared to production without gas exports. Surely these benefits should be important to U.S. foreign policy as well as Mexican domestic development.

SUPPLEMENTAL GAS SUPPLIES

Finally, the study makes an important contribution to understanding how natural gas from Mexico can supplement conventional supplies from the lower 48 States. From this report, it is clear that for the next decade the least expensive source of supplemental gas will be that from Canada and Mexico. Synthetic gas and gas from Alaska will cost more, from 25 to 64 percent more.

Why, then, did the Secretary of Energy say recently:

> We should be reluctant to contract for supplies, even from our neighbors on a take-or-pay basis, if that should be at the expense of American producers—resulting in the shutting-in of domestic capacity or diminishing the domestic incentives for drilling.

Why does the Secretary appear to be discouraging a Mexican gas contract once again?

The Secretary argues that he is protecting domestic producers. The Department should not be protecting domestic producers. They are quite adept at taking care of themselves. The Natural Gas Policy Act did more for producers and less for consumers than any piece of legislation in recent memory. To suggest further protection is, at the very least, poor public policy.

But even on Mr. Schlesinger's own terms, Mexican gas does not threaten domestic producers. The Conference Committee of Congress estimated the 1985 domestic price for new gas at $3.86 per mcf—a price *lower* than the expected price of Mexican gas.

The truth is this new policy is not protecting domestic producers, bad as such a policy might be. It is protecting producers of synthetic gas and the consortium to build the Alaska gas pipeline, both of which are threatened by Mexican or Canadian gas. If a large quantity of Mexican or Canadian gas were available and rolled in with conventional supplies, these most expensive sources would have a hard time competing.

Over the long run, the important thing is to maximize availability of gas as we move towards 1985 when natural gas will be decontrolled. If a large supply exists at that time, consumers have a chance of seeing gas prices rolled back in a free market. This should be possible. Mexico will have a large surplus to export and Canada's surplus is already substantial. In the United States there is, in the phrase the Secretary has borrowed from industry, a "bubble of overdeliverability." Yet in spite of all this increasing supply, the Department is promoting ever more costly projects.

When it comes to creating a competitive market in the future—and lower prices through greater supply—the cutting edge of decision is who gets the benefit of "rolled-in" pricing today. My argument is that the least expensive source should receive that benefit, in this case Mexico and conventional production from Canada.

COMPETING SOURCES

Some argue that an imported source should be handicapped in this competition for reasons relating to our balance of payments. In the case of Mexico, that is a thin argument since over half of our purchases return to the United States in future trade. Others argue that Mexico is not a secure source of supply. Yet even opponents agree that Mexico will have a huge oversupply of gas, that the United States is the only large market available and supplies should thus be reasonably secure.

I am not advocating that the United States buy Mexican gas at any price, but I believe it is a mistake for the Department of Energy to take a hard-line position at this time and for these reasons. Instead, since gas will not be available in the U.S. market for several years, the whole matter should be discussed quietly over time and moved out of the spotlight. The larger issues of Mexican development and the long-term economic relations between the United States and Mexico should be on center stage.

Nor do I oppose, in principle, the Alaskan pipeline. I supported the concept in 1977. However, I am concerned that the American people are being rushed into judgment. The facts have changed since the Congress first approved the project. Its finances are in question and if the financial community has its doubts, surely the Congress should proceed with care.

I believe a complete reexamination of supplemental gas supplies of the United Statex is in order. The appropriate committees in the Congress should look at and compare all competing sources early in this session.

IMPORTANCE OF MEXICAN ECONOMIC DEVELOPMENT

While I have been in the first ranks of those calling for recognition of Mexico's oil and gas resources and encouragement of maximum development, I want to stress that our real concern should be with Mexico's economic and social development over the long term. I stress gas exports because the evidence indicates this is the best course for Mexico. Were the evidence to indicate that beyond a certain level, oil and gas development would be injurious to Mexico, I would urge that we refrain from encouraging or enticing Mexico into production beyond that level.

After energy, the most common touchstone of concern between our two countries is the migration of undocumented workers. Over the long run, only a Mexican economy which is sound and a Mexican society which is prosperous and peaceful will settle the migration issue. We thus have the highest interest in jobs in Mexico.

Hearings before the Subcommittee on Energy last year indicated how few jobs are to be found in oil and gas production, refining and petrochemicals—Mexico's principal investments over the next decades—compared to investments in almost any other sector of industry. It thus becomes crucial that the excess revenues generated by oil and gas be invested in activities which are heavily labor-intensive, particularly tourism, rural development, and small business. The Mexican Government intends to make such investments and the United States

should offer every assistance it can render—for example, in agriculture and fishing—whenever called upon. In trade negotiations, the United States should recognize the role it can play in creating a large number of jobs, understanding where Mexico needs access to U.S. markets and avoiding the promotion of labor-saving machines for an economy which is labor-rich.

It is the flashpoints around the world which make foreign policy headlines, frequently alerting us, too late, to what might have been avoided with thoughtful concern in advance. In spite of brave words to the contrary, Mexico has been too close to home and too stable to evoke the genuine concern of our Government. We can be thankful that oil discoveries have alerted us to the true dimensions of the opportunities and pitfalls in the affairs of our two countries.

The true challenge on both sides of the border goes beyond capitalizing on the sensational news about oil. Energy will work itself out naturally enough if the larger issues are resolved. Because oil was discovered, our two countries will not suddenly become reconciled in an amalgam of modern development. We will remain richly divergent societies.

It is because of our separate courses of development and our divergent cultures that we should seek a complementary relationship. In this endeavor, we should be guided not by economics alone but by an appreciation of the cultural heritage of Mexico. The United States is a country which has renewed a sense of purpose from the wellsprings of diversity. Americans of Mexican descent offer this opportunity for renewal to the rest of our country today.

At the conclusion of a long essay on the differences between Mexico and America, Octavio Pas, the brilliant Mexican writer, recently spoke about the "others" in the world, "the minorities inside, as well as the marginal countries and nations outside." At the conclusion of the essay, he wrote:

> Not only do we make up the majority of the human race, but also each marginal society, poor though it may be, represents a unique and precious version of mankind. These are times for gravity. If the United States is to recover fortitude and lucidity, it must recover itself, and to recover itself it must recover the *others*—the outcasts of the Western World."

Beyond energy and economics, the accident of oil wealth represents an opportunity to seek the common bond of humanity which neighbors on the same continents share. It is never too late for a great power to learn from a friend whose fortunes are on the rise.

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MEXICO'S OIL AND GAS POLICY: AN ANALYSIS

The purpose of this report is to examine Mexico's oil and gas policy for the period 1978 to 1988 and evaluate its most likely effect on Mexican-United States relations. The backdrop of this report is Mexico's recent major oil and gas discoveries. The true extent of discoveries beyond the proved reserve estimates announced by PEMEX, the Mexican national oil company, will remain unknown until more developmental drilling takes place. Rather than enter the debate over the ultimate reserves of oil and gas in Mexico, the Congressional Research Service (CRS) assumes the most certain estimates of Mexico's oil and gas resources for the purpose of its analysis, that is, the official estimates of Mexico's proven and probable reserves as of September 1, 1978.

Using this certain reserve basis, the CRS attempts to forecast Mexico's oil and gas production levels to 1988. The main strength in the forecast is *not* the exactness of the prediction but in the *trends* the forecast shows and in the assumptions behind the forecast. The trends are the end result of a realistic appraisal of the technical feasibility of producing Mexico's oil and gas resources based on current information.

Summary of Major Findings

OIL AND GAS RESERVES AND RESOURCES

(1) Mexico contains a hydrocarbon resource of major proportions. The official proven and probable reserve estimates now total 57 billion barrels of oil, gas equivalents, and gas liquids.[1] These reserves are now supporting production of 1.4 million barrels of oil per day and 2.5 billion cubic feet of gas per day and could support much more. Of the current oil production, 440,000 barrels per day is exported.

(2) Current indications are that a significant hydrocarbon resource is present, perhaps in the 30 to 50 billion barrel range, with the possibility of even a larger amount. The ultimate resource size, while extremely important to long-range Mexican economic prospects, will not affect short-term production. The current proven and probable reserves can support stepped up production. Over the next ten years, production increases depend upon constructing the necessary oil production and transportation facilities, upon profitable use of associated natural gas and upon making proven the probable reserves. These increases do not require discovery of additional petroleum reserves nor do they depend upon the ultimate size of the resource base, which is as yet unknown.

[1] Note: On January 2, 1979, PEMEX announced the following increases in oil and gas equivalent reserve estimates: Proven—40.1 billion (28.9 billion barrels of oil and 65.1 trillion cubic feet of gas); and probable—44.6 billion (32.1 billion barrels of oil and 72.4 trillion cubic feet of gas). Potential reserves remained at 200 billion, as in the September 1978 figures. The doubling of proven reserves in four months with a relatively modest drilling program indicates either exceptional resource concentrations or a less vigorous definition of proven reserves than in the rest of the world or delayed disclosure of reserves known prior to September 1, 1978.

(3) To more than double oil production by the mid-to-late 1980's, as CRS believes could be done with the current proved and probable reserves, will require a considerable increase in the amount of investment, management effort, and equipment as well as a larger number of technical personnel. One byproduct of increasing the level of oil production will be the production of larger quantities of gas. This gas will have to be consumed domestically, sold internationally or flared.

(4) Mexico's potential for additional oil and gas discoveries seems to be good. About 150 structures, which appear similar to the Reforma fields, have been located in the region by geophysical techniques. However, geophysical surveys do not provide direct measurements of in place oil or gas and the indicated structures must be tested by drilling to determine the presence of commercial oil and gas deposits. It has been estimated by Petroleos Mexicanos (PEMEX) that Mexico's overall petroleum *potential* is about 120 to 200 billion barrels, which if proven would rank it with the giant oil producers of the Middle East. It is, however, too early in the exploration and production cycle to determine if so large a resource base in reality exists.

MEXICO'S OIL AND GAS EXPORT POLICY TO 1988: AN EVALUATION

(5) Based on an analysis of Mexico's reserves and resources, and using estimates of capacity increases developed by PEMEX and of domestic demand developed by the Mexican Petroleum Institute (IMP), CRS has projected oil and gas production from 1978 to 1988 (see Tables A and B). Two polar cases were considered in arriving at oil and gas production estimates: Case I assumes maximum gas exports, and Case 2 assumes no gas exports. The key to increased oil production is profitable gas use. Large amounts of gas are dissolved in the oil, particularly in the area of Mexico's greatest oil production, the prolific Reforma producing region. This gas is unavoidably produced in association with the production of oil. If Mexico does not export gas, cannot use all of it domestically and refuses to waste it, then projected oil production will have to be reduced. A critical variable is the possibility for large growth in Mexico's domestic gas demand.

(6) Mexico will experience rapid energy demand growth as its economy expands, but oil exports should continue to rise even faster. Mexican oil is very attractive to U.S. refiners because of the short distance from the producing area in Mexico to the U.S. Gulf Coast, the desirable refining characteristics of the oil, and the favorable credit terms allowed by PEMEX. Mexican oil, therefore, is likely to be imported into the United States at close to the maximum levels allowed by PEMEX. Mexico, despite its emergence as a major oil exporter, is not likely to join OPEC, although it is likely to follow its pricing strategy. If it joined OPEC, Mexico would lose its favored trade status and risk OPEC-induced production cutbacks in a surplus market.

PROJECTED MEXICAN OIL AND GAS PRODUCTION, DEMAND AND EXPORT POTENTIAL

TABLE A.—CASE 1: WITH GAS EXPORTS

Year	Million barrels per day			Billion cubic feet per day					
	Crude oil production	Domestic crude oil demand	Oil export potential	Associated wellhead gas production	Nonassociated wellhead gas production	Total gross production	Net available gas	Domestic gas demand	Exportable gas
1978	1.4	1.0	0.4	1.7	0.8	2.5	1.7	1.7	0.3
1979	1.8	1.1	.7	2.2	.8	3.0	2.6	1.8	.8
1980	2.2	1.1	1.1	2.6	.8	3.4	2.9	1.9	1.0
1981	2.3	1.2	1.1	3.0	.8	3.8	3.3	2.0	1.3
1982	2.4	1.3	1.1	3.4	.8	4.2	3.7	2.1	1.6
1983	2.6	1.4	1.2	3.9	.8	4.7	4.0	2.2	1.8
1984	2.8	1.5	1.3	4.5	.8	5.3	4.4	2.3	2.1
1985	3.1	1.5	1.6	5.3	.8	6.1	5.2	2.5	2.7
1986	3.3	1.6	1.7	5.9	.8	6.7	5.8	2.6	3.2
1987	3.6	1.7	1.9	6.8	.8	7.6	6.4	2.7	3.7
1988	3.8	1.8	2.0	7.6	.8	8.4	6.9	2.9	4.0

TABLE B.—CASE 2: WITHOUT GAS EXPORTS

Year	Million barrels per day			Billion cubic feet per day					
	Crude oil production	Domestic crude oil demand	Oil export potential	Associated wellhead gas production	Nonassociated wellhead gas production	Total gross production	Net available gas	Domestic gas demand	Exportable gas
1978	1.4	1.0	0.4	1.7	0.8	2.5	1.7	1.7	
1979	1.8	1.0	.8	2.2	.5	2.7	2.3	2.3	
1980	2.2	1.1	1.1	2.6	.4	3.0	2.6	2.6	
1981	2.3	1.1	1.2	3.0	.3	3.3	2.8	2.8	
1982	2.4	1.1	1.3	3.4	.3	3.7	3.1	3.1	
1983	2.5	1.2	1.3	3.8	.3	4.1	3.5	3.5	
1984	2.6	1.2	1.4	4.2	.4	4.6	3.8	3.8	
1985	2.7	1.2	1.5	4.6	.6	5.2	4.4	4.4	
1986	2.8	1.2	1.6	5.0	.7	5.7	4.8	4.8	
1987	2.9	1.3	1.6	5.5	.8	6.3	5.2	5.2	
1988	3.0	1.4	1.6	6.0	.8	6.8	5.6	5.6	

MEXICAN ECONOMIC PROBLEMS AND THE ENERGY PLAN

(7) The Mexican economy is recovering from the economic difficulties reflected in the peso devaluation of September 1976. In 1978, business confidence is growing, credit is becoming more available, the government budget is moving toward a balanced position, industrial expansion is underway, the value of the peso appears to have stabilized, and there is renewed confidence founded on the prospect of large oil and gas deposits. However, Mexico has serious problems, such as inflation and unemployment, which will adversely affect Mexico's economy in 1978 and in years to come.

(8) The two cases outlined in Tables A and B are analyzed using the Wharton Econometric Forecasting Associates Mexican Model to determine the effects of various oil and gas production levels on the performance of the Mexican economy. The economic impact of the two cases are shown in Table C. The export of 2 million barrels a day (MMBD) of oil plus 4 billion cubic feet a day (BCF/D) of gas in 1988 (Case 1) compared to exports of 1.6 MMBD of oil and no gas (Case 2) results in:

1. A somewhat stronger economy, but not significantly so in 1988 (5 percent more gross domestic product (GDP)).

2. A somewhat stronger petroleum sector with weaker trade and service sectors.
3. Less inflation.
4. More disposable income per capita (4 percent).
5. Slightly more investment (4 percent) and employment (4 percent).
6. A positive balance of payments verses a negative balance.
7. Lower external debt/GDP ratio.

TABLE C.—ECONOMIC IMPACT IN MEXICO OF ALTERNATIVE ENERGY SCENARIOS [1]

Economic indicators	1978	1983		1988	
		Case 1	Case 2	Case 1	Case 2
Gross domestic product (billion 1960 pesos)	435	598	601	833	798
GDP by sector of origin (percent):					
Agriculture	9	7	7	6	6
Construction	5	5	5	6	6
Electricity	2	2	3	3	3
Manufacturing	24	24	24	24	24
Mining	1	1	1	1	1
Petroleum	6	9	8	10	8
Trade	29	29	29	29	30
Transportation and communication	4	4	4	3	4
Other	20	19	19	18	18
GDP implicit price deflator (1960=1)	4.8	9.5	9.8	17.5	18.7
Inflation rate (percent)	20	12	13	13	14
Consumer Price Index (1960=1)	4.2	8.5	8.8	16.1	17.4
Per capital disposable income (thousand 1960 pesos)	4.8	5.5	5.6	6.7	6.4
Gross fixed investment (billion 1960 pesos)	93.7	138.5	138.7	208.4	200.4
Employment (million workers)	18	21	21	25	24
Balance on current account (billion dollars)	−2.1	−1.3	−2.5	+3.5	−6.0
Public external debt/GDP	24.4	13	14	5	11
Index—Average annual exchange rate (1960=1)	1.8	2.0	2.1	2.5	2.9

[1] Case 1 projects crude oil exports at 2,000,000 bbl/d in 1988, with natural gas exports at 4,000,000,000 ft³/d. Total output in that year is estimated at 3,800,000 bbl/d of oil and 8,400,000,000 ft³/d of gas. Case 2 projects 1988 crude oil exports at 1,600,000 bbl/d with all natural gas produced being used within the country. Total output in 1988 is estimated at 3,000,000 bbl/d of oil and 6,800,000,000 ft³/d of gas.

On balance it would appear that higher export levels of oil and natural gas would be economically beneficial to the Mexican economy, particularly in regard to control of inflation and improvement of the balance of payments. Because of rapidly rising population, revenues from petroleum exports would result in little relative progress on the employment problem, although substantial numbers of jobs would be created.

IMPACT OF MEXICAN OIL AND GAS ON U.S. ENERGY POLICY

(9) Mexican oil could displace some Alaskan oil on both the Gulf and Pacific Coasts of the United States. This could present a serious problem to Alaskan North Slope producers who at present have no export option and who need substantial sales in both markets if they are to maintain production and pipeline throughput levels. Faced with large sunk costs and no real alternatives other than "shutting in" production, Alaskan producers would be forced to discount Alaskan oil to the extent necessary to undersell Mexican oil and to maintain their market shares. Slightly lower crude oil costs for domestic U.S. refiners could be the result.

(10) When compared to future supplemental gas supplies available to the United States in the 1980's, such as Canadian imports, synthetic natural gas with naptha as a feedstock, Alaskan gas, and coal gasification gas, Mexican gas, at least as of 1985, appears to offer a substantial gas supply potential to meet additional gas needs at a price with which only Canadian imports can compete. However, the political consequences surrounding the abrupt termination of natural gas negotiations in early 1978 between PEMEX and six U.S. natural gas pipeline companies has made future U.S. access to Mexican gas uncertain.

ENERGY AND FUTURE UNITED STATES-MEXICAN RELATIONS

(11) The pattern of United States-Mexican trade is changing. The United States has historically had a large positive trade balance with Mexico, but in recent years it has declined. Due to increasing imports of petroleum products from Mexico, 1978 may be the first year in which the U.S. trade balance with Mexico becomes negative. In absolute terms the value of U.S. exports to Mexico will not decline. In order to continue its growth, Mexico will have to import considerable quantities of capital goods plus increased amounts of foodstuffs for its rapidly growing population, much of which will come from the United States.

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INTRODUCTION

Mexico has become the focus of intense speculation in the petroleum world. Some experts assert that, because of the many untested but promising geological formations and the quality of known fields, Mexico could have over 100 billion barrels of recoverable oil—a staggering total that would be surpassed only by the 150 billion barrels of proven and probable oil reserves attributed to Saudi Arabia. Even if Mexico eventually proves to have only one-half of the estimate, 50 billion barrels would still be more than all of the proven and probable oil reserves in the United States.

Petroleos Mexicanos (PEMEX), the state oil company, has announced an ambitious plan to develop Mexico's oil and gas resources between 1977 and 1982. The plan, which estimates place at a cost of more than $16 billion, should result in the export of 1.1 million barrels of oil per day (MMBD) by 1980. PEMEX expects the plan to generate a sorely needed $10 billion in foreign exchange during the period 1977–1982.

The Congressional Research Service (CRS) was asked to examine the PEMEX oil and gas development plan, its effect on Mexico, its potential impact on U.S. energy policy and on United States-Mexican relations during the next decade, 1978–1988. In response, the CRS first examined the oil and gas resource base on which the plan depends and asked the following questions: (1) which reserve estimate would be prudent to use for analysis? (2) what are the production rates possible from those reserves, when will these rates realistically be attained, and how long will they be sustained? and (3) how will Mexico's technical, economic and political factors affect and be affected by the production of the oil and gas reserves.

Second, the CRS examined Mexico's present and future internal demand for oil and gas. This is an important factor in determining its export potential since Mexico has stated it would satisfy its own demand first before considering any exports. The major questions are: (1) what sectors use oil and gas, and how much more energy will these sectors need in the future? and (2) how easy would it be for oil users to convert to gas and vice versa in the event it became more profitable to sell either oil or gas in the international market?

Third, the CRS examined the most likely levels for Mexican oil and gas exports and asked: (1) what are the most likely exportable oil and gas estimates for Mexico between 1978 and 1988? (2) where are the most likely international markets for Mexico's oil and gas exports? and (3) how will Mexico and the Organization of Petroleum Exporting Countries (OPEC) interact over the next ten years?

Fourth, the CRS examined the potential impact of the PEMEX plan on Mexico's economy. The major questions are: (1) what are the major economic problems facing Mexico and what will the revenues from

oil and gas sales mean to those problems? and (2) how will Mexico's own development needs determine the rate at which its oil and gas is developed?

Fifth, the CRS examined the potential impact of Mexican production on U.S. energy policy. The major questions are: (1) what is the current and future demand in the United States for imported oil and gas? and (2) what are the advantages and disadvantages for the United States in importing Mexican oil and gas?

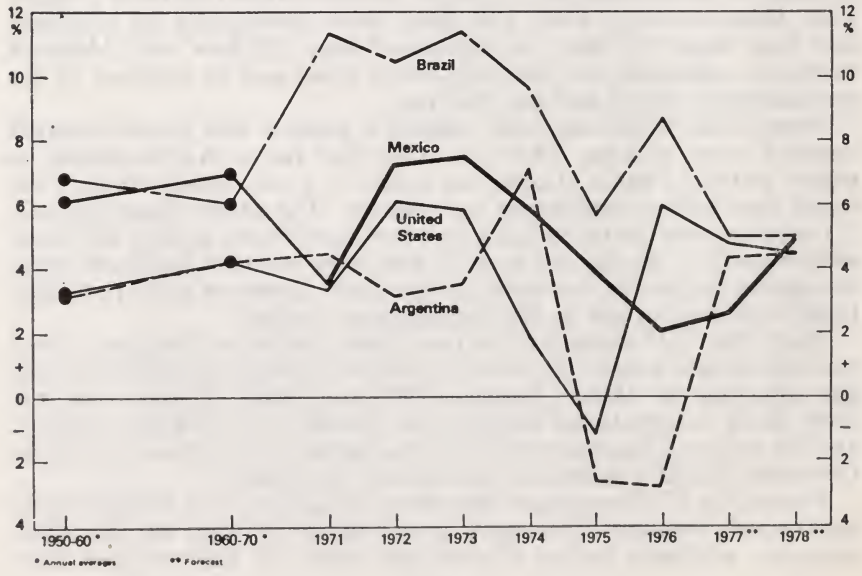
Sixth, the CRS examined the potential impact, if any, of Mexican oil and gas overall on future United States-Mexican relations.

THE ECONOMIC SETTING

Prior to the early 1970's, the Mexican economy had 20 years of impressive growth in gross domestic product (GDP) averaging six to seven percent per year with relative price stability. On the basis of the gross national product (GNP), which is the GDP adjusted for imports and exports, Mexico's growth appeared impressive compared to developed countries like the United States or developing countries like Brazil and Argentina (see Chart 1). Prices rose excessively in 1969 and 1970, but remedial action reestablished stability after the recession of 1971. Since 1972, inflation has plagued the economy rising to 20 percent in 1974 and again in 1976. Mexico's balance of payments deficit worsened, and its international credit rating plummeted exacerbating its domestic problems. In 1976, Mexico allowed the peso to float on the international monetary exchange, resulting in a 50-percent devaluation.

GROWTH IN REAL GNP (%)

CHART 1



Source: *Euromoney*, April 1978, p. 25.

Some of Mexico's economic problems between 1974 and 1976 were consequences of its heavy trade dependence on the United States. In 1974, 56 percent of all Mexico's exports went to the United States and 62 percent of Mexico's imports came from the United States. The U.S. recession in 1974 caused a significant decrease in demand for Mexican goods and, as the Mexican inflation rate got increasingly out of line with that of the United States, Mexican exports became increasingly noncompetitive. American imports were cheaper relative to Mexican products and Mexico's balance of trade worsened.

Perhaps the greatest contributors to Mexico's economic problems in the 1974–76 period were the political and economic policies of Mexico's Federal Government, which expanded government spending. The Government significantly increased investments in public projects such as roads, education and agriculture, at a time when Mexico's real gross domestic product and private investment were declining. Tax revenues did not keep pace with increased governmental expenditures. The higher purchasing power in Mexico's private sector was not balanced by any appreciable increase in the supply of domestically produced goods. The result was inflation and more imports.

In addition, the Government of Mexico made no attempt to discourage exchanging the peso for foreign currencies particularly the U.S. dollar. Instead the populist policies of the Administration provoked panic in Mexico's wealthy class producing a "capital outflow," the dimension of which was unprecedented. As much as $4.5 billion left Mexico before the devaluation in August 1976, a huge amount considering Mexico's GDP was only $60 billion.

Mexico's current Administration, led by President Lopez Portillo, has set out to restore domestic and international confidence in Mexico. The Government contends the private sector should lead Mexico's recovery. In 1977, the Mexican Government and several industrial groups signed agreements calling for private sector investments during the next six years totaling $8 billion. This is expected to generate 300,000 jobs. The government has made strides toward bringing inflation under control by successfully limiting wage demands to ten percent during 1977, a year in which inflation was more than double that.

Internationally, President Lopez Portillo has taken steps to improve perceptions of Mexico, first by visiting the United States to strengthen relations and second by assuring the International Monetary Fund (IMF) that Mexico would honor the stringent terms of the economic austerity program in effect with the IMF.

During 1977, the rate of accumulating external debt slowed, and stability in the exchange rate of the peso occurred. Increased world prices for some of Mexico's exports, such as coffee, cotton and tomatoes, contributed to an improved economy. In 1977, crude oil exports more than doubled to 220,000 BD and improved Mexico's balance of trade deficit. For 1978, Mexico's gross domestic product is expected to grow five percent in real terms after 1977's 3.2 percent, and most observers feel a real growth rate of six to seven percent annually is possible for the next four years.

However, Mexico has some serious economic problems which could undermine the country's promising economic future. Unemployment and underemployment are high, with some combined estimates ap-

proaching 50 percent. Mexico's agricultural productivity has decreased, and, as a result, Mexico is being forced to import food to feed its growing population. Despite some improvement, Mexico's large balance of trade deficit and sizable external (foreign) debt may act as a constraint in raising development capital on the international money markets.

EARLY OIL PRODUCTION

Present Mexican oil and gas policy has roots going back to the turn of the century when Mexico first started producing oil. After oil production began in Texas, Mexican President Porfirio Diaz sought to attract foreign money for oil development of Mexico by allowing foreign investors to own the mineral rights to the land, which was a departure from traditional government policy. This policy along with a favorable tax policy attracted first the British, and later American and Dutch oil interests to Mexico. The influx of foreign oil interests was not deterred by Mexico's revolution. Exports continued to grow, and by 1977, with American and British companies participating in the effort, production exceeded 125,000 BD, most of which was exported to the United States.

The Revolution brought sweeping social and legal reform which would affect the course of subsequent Mexican oil and gas policy. The Constitution of May 1, 1917, the embodiment of the reforms, included two clauses of particular importance to the oil industry. One clause reasserted Mexican Government ownership of subsurface resources, and the other gave the Mexican Government the right of expropriation in the public interest. In the United States, private and Federal reaction was negative, and demands were made for clarification. In the so-called Texas Company Cases, the Mexican Supreme Court ruled that the provisions of the constitution were not retroactive. The U.S. interpretation of this decision was that companies operating prior to May 1, 1917, continued to own the oil deposits.[1] By 1921, Mexico was producing 530,000 BD and was the second largest producer in the world after the United States, accounting for a quarter of world production.

The predominant Mexican interpretation of its constitution, however, was changed. The Mexicans began to claim that foreign oil companies had vested rights to explore and produce, but did not own the oil deposits. By way of clarification, Mexico passed a law in 1925 requiring the foreign oil companies to exchange their titles to oil land for 50-year concessions. The U.S. reaction was again adverse, and in 1927, the Mexican Supreme Court ruled the concession rights were perpetual.[2] The controversy was temporarily settled.

Relations between the foreign oil companies and the Mexican Government worsened. The companies kept the price of Mexican crude oil high when the world was entering a major economic depression. Mexico began to tax the oil companies and, as a result, it became more profitable for the American oil companies to operate in Venezuela, and for the Europeans to get their oil from the Middle East. Mexican oil production declined to 85,000 BD in 1930 resulting in Mexican worker layoffs.

[1] Energy Profile of Mexico, Department of Energy, June 9, 1977, p. 20.
[2] *Ibid.*

During the 1930's, there was a strong swing to a socialist philosophy in Mexican politics, elevating organized labor to a position of political power. The left-wing movement climaxed in the election of Lazaro Cardenas as President in 1934 and the emergence of a strong socialist government.

NATIONALIZATION OF THE OIL INDUSTRY

In 1937, the petroleum workers' union proposed a new contract including demands for higher wages, new safety laws, and higher benefits. The companies rejected the demands, and a strike was called in May 1937. When a government arbitration board gave the union more than it had demanded, the companies delayed implementing the decision and appealed to the Mexican Supreme Court, which decided in favor of the oil workers.[3] With public opinion clearly behind him, President Cardenas nationalized the assets of foreign oil companies. He made use of the clause in the 1917 Constitution which gave the State the right to confiscate private property in the national interest. The state oil company, Petroleos Mexicanos (PEMEX), was formed to take over the interests of the nationalized companies.

The American, British, and Dutch oil companies boycotted the nationalized oil, and the Mexicans were eventually forced to pay $130 million in compensation for seizing the companies. The boycott was lifted to meet World War II demands, but production remained below 100,000 BD. Production was increased after the war reaching almost 200,000 BD in 1950. Postwar economic growth, however, led to rapid increases in domestic oil demand which soon outstripped production and forced Mexico to become a net oil importer. Only recently (September 1974) has it once again become an exporter. During the period since the War, PEMEX has developed an administrative structure to produce and distribute petroleum within Mexico and to purchase and sell oil in world markets. Relations with foreign companies were limited to purchases of oil and equipment.

The history of nationalization, the boycott, and other related events have contributed the following to the development of Mexico's oil industry. First, Mexico is one of the few developing countries today which has both indigenous oil and the sophisticated technical expertise to produce it. Second, the experienced petroleum engineers and managers of PEMEX are members of a politically powerful union which enjoys good salaries, and liberal benefits. Third, PEMEX is expected to fulfill an important social mission—to supply oil and related products at low prices to Mexican consumers. Finally, PEMEX has become a symbol of the country's economic independence. As a result, Mexicans are intensely nationalistic about their oil and are wary of foreign oil companies and foreign countries that are perceived as potential exploiters of their resources.

[3] *Ibid.*, p. 21.

OIL AND GAS RESERVES AND RESOURCES

The most recent information from the Mexican government concerning Mexican hydrocarbon reserves was included in President Lopez Portillo's annual report to the nation delivered on September 1, 1978. The Mexican President announced that proven domestic oil and gas reserves currently total 20 billion barrels, an increase of four billion from the previously announced figure of last March. Probable reserves were given at 37 billion barrels and possible reserves were raised to 200 billion barrels. This latest proven reserve figure would translate to about 14.4 billion barrels of oil and 32.5 trillion cubic feet of natural gas.

Another recent estimate which divides hydrocarbon reserves into oil, condensate, and gas has been published by World Oil. Proven reserves are 9 billion barrels of oil, 1.3 billion barrels of condensate, and 27.9 trillion cubic feet of gas. [4] This is distributed throughout the country as follows: Northern Zone—543 million barrels of oil, 278 million barrels of condensate, and 11.3 trillion cubic feet of gas; Angostura—101 million barrels of oil, 45 million barrels of condensate, and 0.8 trillion cubic feet of gas; Poza Rica—1.6 billion barrels of oil, 132 million barrels of condensate, and 2.8 trillion cubic feet of natural gas; and the Southern Zone—6.8 billion barrels of oil, 888 million barrels of condensate, and 13.0 trillion cubic feet of gas. Other estimates of Mexico's oil and gas reserves are given in table 1.

TABLE 1.—ESTIMATES OF MEXICAN OIL AND GAS RESERVES

Year and source	Oil (barrels)				Gas (cubic feet)		
		Production			Production		
	Wells	Per year (billions)	Per day	Reserves (billions)	Per year (trillions)	Per day (billions)	Reserves (trillions)
1975: Oil and Gas Journal, Dec. 29, 1975, p. 86	3,285	0.27	710,000	9.5			12.0
1976: Oil and Gas Journal, Dec. 27, 1976, p. 104	3,382	.31	850,000	7.0			12.0
1976: DeGolyer and MacNaughton, Oil and Gas Journal, May 2, 1977: Oil and gas equivalent (for 4 Reforma fields only)				11.0			
				*7.9			*17.9
1977: Oil and Gas Journal, Dec. 26, 1977, p. 100	3,419	.35	953,000	14.0	0.803	2.2	30.0
1977: World Oil, Aug. 15, 1978: Oil plus condensate				10.4	.730	2.0	27.9
1978 (March): PEMEX, Ocean Industry, May 1978, p. 42: Oil and gas equivalent:							
Proven				16.0			
				*11.5			*26.0
Probable				31.0			
				*22.3			*50.3
Potential				120.0			
				*86.4			*194.9

[4] Mexico. World Oil, August 15, 1978, p. 72.

TABLE 1.—ESTIMATES OF MEXICAN OIL AND GAS RESERVES—Continued

Year and source	Oil (barrels)				Gas (cubic feet)			
		Production			Production			
	Wells	Per year (billions)	Per day	Reserves (billions)	Per year (trillions)	Per day (billions)	Reserves (trillions)
1978: CIA, Oct. 4, 1978, p. 4 (proven and probable)				30.0			46.0
1978: President Portillo, Sept. 1, 1978:							
Oil and gas equivalents:							
Proven				20.0			
				*14.4			*32.5
Probable				37.0			
				*26.6			*60.1
Possible				200.0			
				*144.0			*324.8

*Note: On Jan. 2, 1979, PEMEX announced the following increases in oil and gas equivalent reserve estimates: Proven—40.1 billion (28.9 billion barrels of oil and 65.1 trillion cubic feet of gas); and probable—44.6 billion (32.1 billion barrels of oil and 72.4 trillion cubic feet of gas). Potential reserves remained at 200 billion, as in the September 1978 figures. The doubling of proven reserves in four months with a relatively modest drilling program indicates either exceptional resource concentrations, a less vigorous definition of proven reserves than in the rest of the world, or delayed disclosure of reserves known prior to Sept. 1, 1978.

When considering Mexico's proven hydrocarbon reserves, a figure of 11 billion barrels, as estimated by DeGolyer & MacNaughton in 1976, is a minimum volume which can safely be used for planning.

RESERVES AND PRODUCTION CAPABILITY

The recovery of petroleum relies on the pressure within the reservoir (either natural or induced by water flooding). Maximum hydrocarbon yield is obtained by releasing this pressure in a controlled fashion. In general, this means that it is impossible to produce more than ten percent of the recoverable petroleum reserves in any one year without reducing the total amount of petroleum that can be eventually recovered. In some fields it may be possible to produce at a faster rate (and this may be the case in the highly permeable Reforma fields) and in other fields the rate may be lower, but overall world experience has been that a proven reserves-to-production ratio of ten-to-one is probably the maximum production rate for a field that is feasible and efficient.[5] But, to use this figure would imply that all known fields in Mexico are developed and producing at a maximum rate. For countries where there are fields included in proven reserves estimates that are still under development, a proven reserves-to-production ratio of fifteen-to-one is a more justifiable estimate of the maximum production rate.[6]

Using the fifteen-to-one factor, maximum production from proven reserves of 11 billion barrels of hydrocarbons would be 0.73 billion barrels per year or 2 million barrels per day. The 11 billion barrels of hydrocarbon reserves are thought to be broken down into approximately 7.9 billion barrels of oil and 17.9 trillion cubic feet of gas. Since a maximum reserves-to-production ratio of fifteen-to-one has been assumed, maximum yearly production of oil from 7.9 billion barrels of reserves would be 0.53 billion barrels per year or 1.4 million

[5] Wilson, Carroll L. Energy Global Prospects 1985–2000. McGraw Hill Book Company, New York, 1977, p. 156.
[6] Ibid.

barrels per day. Actual Mexican production amounts to about 1.4 million barrels of oil per day. Under the conservative assumption of 11 billion barrels of reserves, there would appear to be little capacity for the expansion of oil production without the discovery of additional oil reserves.

However, the September 1978 figure given by Mexico for proven reserves of oil, gas equivalent, and gas liquids is 20 billion barrels. Using a reserves-to-production ratio of fifteen-to-one, maximum production from these reserves would amount to 2.6 million barrels of oil per day. As current production is 1.4 million barrels of oil per day, it would appear that oil production from proven reserves could be substantially expanded. Thus to achieve the oil production (projected by PEMEX) of 2.2 million barrels per day by 1980 will not require the discovery of additional proven oil reserves.

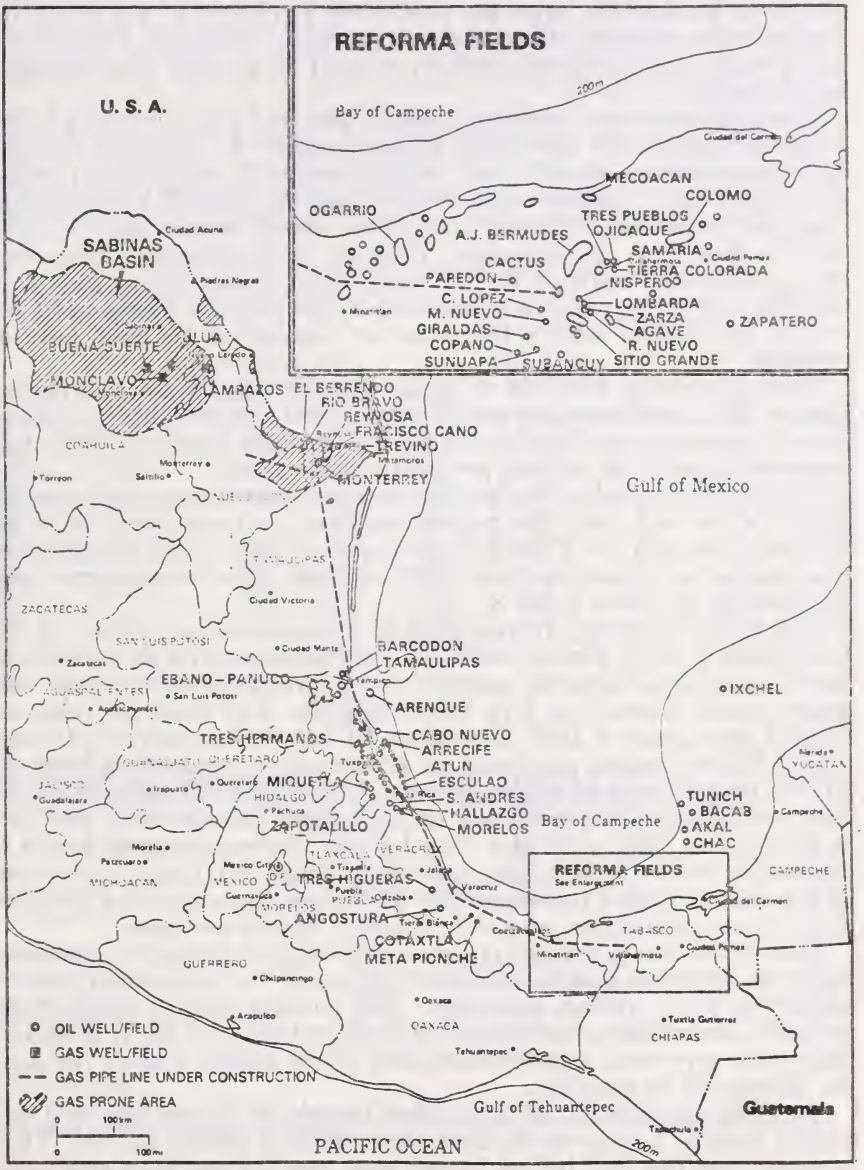
If most of this oil comes from central Reforma fields with gas/oil ratios of 1,000:1 (at the lowest), 2.5 billion cubic feet per day of associated gas would be produced along with the oil. The associated gas produced would have to be utilized domestically, reinjected, sold abroad, or flared. Reinjection of gas cannot be used to enhance recovery in most of the Reforma fields, as waterflooding is required.

Production of 2.2 million barrels of oil per day by 1980 would require considerable increases in investment and equipment. Increases in investment for pressure maintenance facilities would be a significant cost, because most Reforma fields (see chart 2) will require the injection of at least two barrels of water for each barrel of oil produced to maintain desired pressures. By 1979, PEMEX expects to be injecting one million barrels of water per day into the Samaria-Iride-Cunduacan field, with some 40 input wells each averaging 25,000 barrels of water injected per day. The water will be handled by 20 turbine-driven pumps, each with a capacity of 50,000 barrels of water per day.[7] These systems must be in place to produce the fields properly. Maintaining pressures in Reforma fields is required at an early stage as the reservoirs are undersaturated and have a tendency to lose pressure quickly.

[7] Franco, Alvaro. Giant New Trend Balloons SE Mexico's Oil Potential, The Oil and Gas Journal, September 19, 1977. p. 84.

Chart 2

MEXICO'S OIL AND GAS FIELDS



Source: *World Oil*, August 15, 1978, pg. 73.

Mexico's potential for additional discoveries appears to be very good. Geophysical surveys have located more than 150 structures that may be geologically similar to the successful Reforma fields.[8] There are other potentially large gas producing provinces in the State of Coahuila in northern Mexico and in the Baja California Peninsula.[9] For a geological description of the potential oil and gas bearing areas see appendix.

Potential reserves of crude oil, natural gas, and gas condensate have been estimated to be 120 to 200 billion barrels.[10] If the lower volume is divided between oil and gas, it would amount to 86.4 billion barrels of oil and 194.9 trillion cubic feet of gas. An overall hydrocarbon resources potential of 120 to 200 billion barrels would give Mexico Middle East size oil prospects. It must be emphasized, however, that geophysical surveys do not measure in place oil or gas, and that the structures which are indicated by geophysical means must be drilled and tested before they can be considered to hold proven reserves.

When projecting Mexican oil production into the future, it is necessary to take factors such as gas/oil ratios, production of dry gas, number of exploration and production wells drilled per year, and projected domestic demand for oil and gas into consideration.

Taking into consideration proven and probable reserve estimates of Mexico's oil and gas, the proven reserves to production ratio of fifteen-to-one and the PEMEX development plan, CRS constructed two production scenarios from 1978 to 1988. The two scenarios are summarized in tables 2 and 3.

The tables show the relationship of production to reserves. If oil production in 1988 were to increase from the current 1.4 to 3.0 million barrels per day, the total amount of oil produced in the next ten years would amount to 9.71 billion barrels. The total oil reserves needed to support a 1988 production of 3.0 million barrels per day (1.095 billion barrels per year) at a reserves to production ratio of fifteen to one is 16.43 billion barrels. Thus the total amount of oil reserves needed if a production of 3.0 million barrels of oil per day is reached in 1988 is 26.14 billion barrels. Proven reserves are 14.4 billion barrels, so 11.74 billion additional barrels of oil must be proven in the next ten years to support the 3.0 million barrel per day production, a reserve addition rate of 1.17 billion barrels per year.

This additional proven oil could come from the category of probable reserves. Probable reserves represent expected, but not certain, recoverable oil from known reservoirs. The current official estimate of probable reserves is an additional 26.6 billion barrels of oil. If probable reserves are proven, a production level of 3.0 million barrels per day in 1988 would be possible.

Similarly, production of 3.8 million barrels of oil per day by 1988 would require a reserve, at that time, of 20.8 billion barrels. This amount plus the 10.7 billion barrels that would have been produced from 1978 to 1988 equals 31.5 billion barrels of oil, the amount necessary to allow a 3.8 million barrel level of production. Since proven reserves are estimated at 14.4 billion barrels, 17.1 billion barrels of

[8] Mexico's Combined Reserves Hit 16 Billion Barrels. The Oil and Gas Journal, April 17, 1978.
[9] Ibid.
[10] PEMEX Director General Reports on Mexico's Outlook. Ocean Industry, May 1978. p. 42–44.

additional oil will have to be proven in the next ten years, a rate of 1.71 billion barrels per year. This could come from the estimated probable reserve of 26.6 billion barrels. The logistical problems of increasing production to these levels are significant but can be overcome. A considerable increase in investment management effort, technical personnel and equipment would be required. A large amount of associated gas would have to be sold or flared. A massive water flooding would be necessary, particularly in the Reforma fields. While a 1988 production of 3.8 million barrels of oil per day appears feasible in terms of the potential resource base available, the problems of development on this scale will be significant and must be addressed successfully.

TABLE 2.—MEXICAN OIL PRODUCTION OF 3,000,000 BBL/D IN 1988

Year	Oil production (barrels)		Gas/Oil ratio	Gas production (cubic feet)			
				Per day (billions)		Total	
	Per day (millions)	Per year (billions)		Associated	Non-associated	Per day (billions)	Per year (trillions)
1978	[1] 1.4	0.511	1200:1	1.7	0.8	2.5	0.912
1979	1.8	.657	1200:1	2.2	.5	2.7	1.058
1980	[2] 2.2	.803	1200:1	2.6	.4	3.0	1.095
1981	2.3	.840	1300:1	3.0	.3	3.3	1.204
1982	2.4	.876	1400:1	3.4	.3	3.7	1.387
1983	2.5	.912	1500:1	3.8	.3	4.1	1.495
1984	2.6	.949	1600:1	4.2	.4	4.6	1.679
1985	2.7	.986	1700:1	4.6	.6	5.2	1.971
1986	2.8	1.022	1800:1	5.0	.7	5.7	2.117
1987	2.9	1.058	1900:1	5.5	.8	6.3	2.300
1988	3.0	1.095	2000:1	6.0	.8	6.8	2.482
Total		9.709					17.701

Oil	Billion barrels	Gas	Trillion cubic feet
Total oil produced by 1988	9.71	Total gas produced by 1988	17.70
Total oil reserves need to support 3,000,000 bbl/d production in 1988 at a production/reserves ratio of 1/15	16.43	Total gas reserves needed to support 6,800,000,000 ft³/d production in 1988 at a production/reserves ratio of 1/15	37.23
Total oil needed by 1988	26.14	Total gas needed by 1988	54.93
Proven reserves	14.4	Proven reserves	32.5
Probable reserves	26.6	Probable reserves	60.1
Total	41.0	Total	92.6
Total oil needed by 1988	26.14	Total gas needed by 1988	54.93
Proven reserves	14.40	Proven reserves	32.50
To be added in 10 yr	11.74	To be added in 10 yr	22.43
Reserve addition rate needed (per year)	1.17	Reserve addition rate needed (per year)	2.24

[1] Actual.
[2] PEMEX estimate.

Note: The revised PEMEX Jan. 2, 1979, estimate of 28.9 billion barrels of proven oil reserves and 65.1 trillion cubic feet of natural gas reserves would support this scenario, without additional discoveries.

TABLE 3.—MEXICAN OIL PRODUCTION OF 3,800,000 BBL/D IN 1988

Year	Oil production (barrels)		Gas/Oil ratio	Gas production (cubic feet)			
				Per day (billions)		Total	
	Per day (millions)	Per year (billions)		Associated	Non-associated	Per day (billions)	Per year (trillions)
1978	[1] 1.4	0.511	1200:1	1.7	0.8	2.5	0.912
1979	1.8	.657	1200:1	2.2	.8	3.0	1.095
1980	[2] 2.2	.803	1200:1	2.6	.8	3.4	1.241
1981	2.3	.840	1300:1	3.0	.8	3.8	1.387
1982	2.4	.876	1400:1	3.4	.8	4.2	1.533
1983	2.6	.949	1500:1	3.9	.8	4.7	1.716
1984	2.8	1.022	1600:1	4.5	.8	5.3	1.934
1985	3.1	1.132	1700:1	5.3	.8	6.1	2.226
1986	3.3	1.204	1800:1	5.9	.8	6.7	2.446
1987	3.6	1.314	1900:1	6.8	.8	7.6	2.774
1988	3.8	1.387	2000:1	7.6	.8	8.4	3.066
Total		10.695					20.330

Oil	Billion barrels	Gas	Trillion cubic feet
Total oil produced by 1988	10.7	Total gas produced by 1988	20.33
Total oil reserves need to support 3,800,000 bbld production in 1988 at a production/reserves ratio of —	20.8	Total gas reserves needed to support 8,400,000,000 ft³/d production in 1988 at a production/reserves ratio of ½	45.99
Total oil needed by 1988	31.5	Total gas needed by 1988	66.32
Proven reserves	14.4	Proven reserves	32.5
Probable reserves	26.6	Probable reserves	60.1
Total	41.0	Total	92.6
Total oil needed by 1988	31.5	Total gas needed by 1988	66.32
Proven reserves	14.4	Proven reserves	32.5
To be added in 10 yr	17.1	To be added in 10 yr	33.82
Reserve addition rate needed (per year)	1.71	Reserve addition rate needed (per year)	3.38

[1] Actual.
[2] PEMEX estimate.

Note: The revised PEMEX Jan. 2, 1979, estimate of 28.9 billion barrels of proven oil reserves would decrease the total required oil reserve additions to 2.6 billion barrels. The revised estimate of 65.1 trillion cubic feet of proven gas reserves would decrease the total required gas reserve additions to 1.22 trillion cubic feet.

MEXICO OIL AND GAS EXPORT POLICY TO 1988: AN EVALUATION

Soon after the Lopez Portillo Administration assumed power, it authorized a massive expansion program for PEMEX to begin development of Mexico's oil and gas resources over a six year period (1977 to 1982). The cost of the plan is about $16 billion, three times the amount of its investment during the last six years. Mexico's private sector is also committed to investing $2 billion in secondary petrochemicals [11] bringing the grand total to almost $18 billion, or almost a quarter of Mexico's gross investment over the period.

THE OIL AND GAS DEVELOPMENT PLAN

The main objectives of the PEMEX oil and gas development plan are the following:

Exploration.—Drill 1,300 new wells or 10 times as many as in the previous six years. Cost: $1 billion.

Crude Oil Production.—Increase production from 1.0 million b/d in 1977 to 2.2 million b/d by 1980. Cost: $7 billion.

Refining.—Double capacity to 1.7 million b/d. Cost $2 billion.

Gas Production.—Increase gas production from 2.2 bcf/d to 4.0 bcf/d. Cost: hard to estimate since most of the gas will be associated with oil.

Gas Distribution.—Build gas processing plants to extract gas impurities making it a marketable product. Also included is a project to build a gas pipeline from Cactus up to Monterrey by 1979, linking up with the main gas pipeline system in Mexico. Initial output of the new pipeline would be 847 million cubic feet per day (mmcf/d), but adding compressors would raise its capacity to 2.2 bcf/d. Cost: $2 billion.

Other Oil and Gas Transportation.—Cost of other pipelines, tankers, and transportation: $2 billion.

Petrochemicals.—Triple capacity to 18.6 million tons by 1982. About 500 mmcf/d will be used to make 10,000 tons a day of fertilizer. Ethylene production will go to 1.3 million tons a year. Cost: $2 billion.

Planned Exports.—Exports of crude oil are to go up from 200,000 b/d in 1977 to 1.1 million b/d in 1980. Exports of gas were to approach 2 bcf/d in 1984, but that estimate is dependent on the United States buying the gas for at least $2.60 per thousand cubic feet (mcf).

The development plan is consistent with Mexico's official energy policy of first satisfying its immediate and future domestic needs, second, making rational use of all hydrocarbons, and third, exporting any surplus in order to build an economic development fund. The economic logic behind the development strategy is to reach the crude export goal as soon as possible to help finance the bulk of the plan's

[11] Gordon, *op. cit.*, p. 23.

scheduled outlays which occur in 1978 and 1979. Also important is construction of a gas transportation system capable of delivering gas from the Cactus area to either the U.S. markets or to central Mexico's industrial and power plant markets. This would enable Mexico to reach its crude oil production goal in the Cactus area without wasting valuable natural gas, which is associated with oil in that region.

The PEMEX plan is the Administration's main hope in getting the Mexican economy up to the historical six to seven percent annual growth rate, and reducing the country's balance of payments problems. If all goes according to schedule, the petrochemical and refining phase of the plan will wipe out Mexico's import bill for chemicals and chemical products, which was $700 million in 1976, and will wipe out the fertilizer and petroleum products import bill, which totalled $350 million in 1976. Assuming a constant $13.50 per barrel of oil in 1978 U.S. dollars, revenues from exporting 1.1 million b/d will total $5.4 billion in 1982 alone. Overall, PEMEX director Jorge Diaz Serrano has said that for the duration of the present administration (1977–1982) the company's total gross revenues will reach $59.6 billion.[12] The PEMEX budget will probably have the following expenditures: (1) operating expenses, including Federal taxes, of $32.5 billion; (2) reduction of PEMEX debt by $1 billion, and (3) capital investment of $16 billion as called for in the plan's development. This would leave close to $10 billion from the gross $59.6 billion as revenues which the Lopez Portillo Administration could spend in development of the Mexican economy.

Mexico's economic growth through 1982 is dependent on its ability to develop its oil and gas resources according to schedule. The CRS believes this dependence will continue in the period 1983 to 1988. As a result, the CRS assumes for the purposes of this report that Mexico is willing to make a similar kind of commitment to continue its oil and gas development through 1988.

The success of the initial 1977 to 1982 plan and any subsequent plan from 1983 to 1988 depends to a large degree on the amount of revenue derived from exports of oil and possibly gas. The revenues are needed to help solve Mexico's economic problems which are discussed in a later section. However, President Lopez Portillo has stated that domestic oil and gas demand must be satisfied before any Mexican petroleum will be exported. The purpose of the next section is to evaluate Mexico's potential for exporting oil and gas to international energy-consuming markets by, first, evaluating Mexico's probable demand for oil and gas and, second, deriving a possible production scenario during the period 1978 to 1988.

OIL—DOMESTIC DEMAND: PRESENT AND FUTURE

Petroleum demand in Mexico has been strong since the beginning of the 1940's. Since that time, demand has been doubling approximately every ten years. Mexico, however, started from a relatively small industrial base, and as such these gains are not unusual for a developing country. As revenue from oil sales is used to further develop the Mexican economy, energy demand, particularly for oil and gas, should continue to rise at near historic rates through the 1980's.

[12] The Journal of Commerce, August 14, 1978, p. 1A.

Table 4 shows that between 1940 and 1976, domestic demand grew at a much more rapid rate than supply. This was partially due to the social goal of PEMEX to provide low-cost energy to its consumers, a goal that was reflected in low product prices. Low product prices meant profit margins were compressed, and PEMEX did not have the revenues needed for exploration and development. Consequently, production declined and failed to match the rapidly growing demand. Even as late as 1974, Mexico was a net importer with an annual expenditure of $290 million, which reduced the cash flow of PEMEX even further. The development of the Reforma field, however, has permitted Mexico to once again become an exporter. Exports have exceeded imports for the past three years and are likely to do so for the foreseeable future, even with the continued high domestic demand expected from additional emphasis on industrialization in Mexico.

TABLE 4.—MEXICAN OIL EXPORT/IMPORT BALANCE

[In thousands of barrels per day]

Year	1940	1950	1955	1960	1965	1968	1969	1970	1971	1972	1973	1974	1975	1976
Consumption[1]	64	139	180	298	341	416	452	593	518	610	625	645	650	765
Production	120	199	271	323	368	388	412	430	436	441	465	551	705	850
Balance	+56	+60	+91	+25	+27	−28	−40	−73	−82	−169	−160	−94	−55	+175

[1] Does not include oil used in the commercial generation of electricity.

Source: 1976 International Petroleum Encyclopedia, vol. 10.

PEMEX has estimated that the demand for petroleum products (1976–1985) in Mexico will rise at an average annual rate of 6.0 percent, a lower rate than the 6.9 percent that prevailed in the years 1965–1975 (Table 5). This corresponds to the slight decline in overall expected energy demand in general (7.3 percent compared to 6.9). This lower growth rate is a natural consequence of the larger base on which the projection is made; national growth rates for energy demand usually drop in such circumstances.

TABLE 5.—TOTAL MEXICAN ENERGY DEMAND

[Thousands of MCPCE[1]—Historical 1965–75; projected 1976–85]

Year	Industrial (including natural gas)	Diesel	Gasoline	LP gas	Kerosene	Jet fuel and aviation gasoline	Total petroleum	Electricity generation	Coal[2]	Total
1965	10,469	3,530	5,675	1,908	1,994	371	23,947	1,294	1,010	26,251
1966	11,712	3,908	6,118	2,132	2,038	401	26,309	1,429	1,058	28,796
1967	12,916	4,230	6,781	2,292	2,039	472	28,730	1,612	1,162	31,504
1968	12,900	4,745	7,224	2,420	2,073	547	29,909	1,812	1,268	32,989
1969	14,133	5,193	7,817	2,549	2,027	627	32,346	2,062	1,277	35,685
1970	14,689	5,611	8,436	2,616	2,020	688	34,064	2,320	1,470	37,850
1971	15,873	5,856	9,021	2,657	2,002	725	36,134	2,528	1,746	40,408
1972	16,844	6,393	9,774	3,183	1,959	821	38,974	2,817	1,860	43,651
1973	17,498	7,139	10,869	3,097	2,012	932	41,547	3,096	2,071	46,714
1974	19,040	8,179	11,263	3,386	2,063	1,197	45,128	3,423	2,533	51,089
1975	20,344	9,322	11,486	3,578	2,158	1,193	48,081	3,709	2,616	54,406
Average annual growth rate	3.3	9.6	7.0	6.1	0.3	12.7	6.9	11.3	10.6	7.3

See footnotes at end of table.

TABLE 5. TOTAL MEXICAN ENERGY DEMAND—Continued

[Thousands of MCPCE[1]—Historical 1965–75; projected 1976–85]

Year	Industrial (including natural gas)	Diesel	Gasoline	LP gas	Kerosene	Jet fuel and aviation gasoline	Total petroleum	Electricity generation	Coal[2]	Total
1976	21,009	9,660	12,049	3,911	2,153	1,321	50,103	4,345	2,905	57,353
1977	23,230	10,551	12,651	4,149	2,173	1,450	54,204	4,928	3,158	62,290
1978	23,203	11,490	13,260	4,396	2,194	1,587	58,130	5,506	3,538	67,174
1979	27,266	12,467	13,875	4,650	2,217	1,731	62,206	6,296	3,969	72,471
1980	28,975	13,470	14,476	4,914	2,240	1,831	65,956	7,056	4,375	77,387
1981	31,049	14,483	15,124	5,186	2,264	2,039	70,145	7,757	5,529	83,431
1982	32,843	15,489	15,758	5,466	2,289	2,204	74,049	8,516	6,064	88,629
1983	34,703	16,470	16,400	5,736	2,315	2,376	78,000	9,376	6,578	93,954
1984	36,221	17,403	17,050	6,055	2,342	2,555	81,626	10,301	7,172	99,099
1985	37,730	18,266	17,709	6,364	2,370	2,740	85,179	11,316	7,703	104,198
Average annual growth rate	6.6	7.4	3.2	5.5	1.1	8.4	6.0	11.1	12.3	6.9

[1] MCPCE (cubic meter of oil equivalent) equals 6.2898 bbl.
[2] Does not include fuel used in the commercial generation of electricity.

Source: The Mexican Petroleum Institute (IMP). Sudirecction de Estudios Economicos and Planeacion Industrial. Division de Estudios Economicos.

The largest increase in demand is projected to be in jet and aviation fuel (8.4 percent), followed by diesel (7.4), industrial (6.6), LP gas (5.5), gasoline (3.2), and kerosene (1.1).

For analytical purposes, it is necessary to amend the data made public by PEMEX. Demand figures are stated in units called MCPCE, each of which equates to one cubic meter of oil equivalent or 6.2898 barrels. After conversion, it is also necessary to add the petroleum products used to generate electricity (diesel and fuel oil), a figure which is not given by PEMEX in the national demand table (Table 5). It is also necessary to subtract the energy equivalent of natural gas used in the industrial sector, because PEMEX combines this with the petroleum products used in that sector. Without subtracting the natural gas figures, the total product demand would be overstated; and without adding the products used in the commercial generation of electric power, the total would be understated. The net result is a slight increase in the total domestic demand, which more accurately reflects the demand for oil products than is immediately apparent in the PEMEX data. Table 6, therefore, shows these adjusted figures in terms of both MCPCE per year and thousands of barrels per day.

It should be noted that the CRS made its own projection for oil demand in Mexico for the years 1986–1988. PEMEX's projections extend only to 1985.

Also, the PEMEX demand projections assume significant quantities of natural gas exports. If Mexico did not export natural gas beginning in 1979, then not only would Mexican demand for oil change, but Mexico oil exports would also change (see natural gas analysis sections).

TABLE 6.—PROJECTED MEXICAN DEMAND FOR PETROLEUM PRODUCTS ASSUMING GAS EXPORTS [1]

Year	MCPCE per year [2]	Thousands of barrels per day
1977	53,544.51	922.72
1978	58,559.35	1,009.14
1979	63,612.18	1,096.22
1980	66,148.29	1,136.18
1981	69,875.73	1,204.15
1982	74,569.15	1,285.04
1983	79,226,95	1,365.30
1984	83,523.55	1,435.41
1985	89,019.01	1,534.05
1986		[3] 1,620.00
1987		[3] 1,710.00
1988		[3] 1,800.00

[1] Includes petroleum products used to generate electricity but does not include natural gas used in the industrial sector.
[2] 1 MCPCE (cubic meter of oil equivalent equals 6.2898 barrels).
[3] Consumption growth rate which CRS projected at 5.5 percent compounded annually.

Source: IMP and CRS.

OIL EXPORT POTENTIAL: ASSUMING GAS EXPORTS

Mexico is currently exporting crude oil at modest levels, a total of 220,000 b/d of crude oil and petroleum products in 1977. Of that amount the United States imported an average of 177,139 b/d of crude oil and 2,137 b/d of product for a total of 179,276 b/d.

The CRS projections for Mexican oil exports for 1978 to 1988, assuming natural gas exports are maximized, are summarized in Table 7. The CRS methodology used to develop these projections was based on analysis of Mexico's resource potential already discussed in an earlier section, and on supply estimates by PEMEX and the Mexican Petroleum Institute (IMP).[13]

TABLE 7.—EXPORT PROJECTIONS FOR MEXICAN CRUDE OIL ASSUMING GAS EXPORTS

[In millions of barrels per day]

Year	Mexican production	Mexican demand	Export potential	Export/production ratio
977	1.1	0.9	0.2	0.18
978	[1] 1.4	[2] 1.0	.4	.29
979	[1] 1.8	[2] 1.1	.7	.39
980	[1] 2.2	[2] 1.1	[1] 1.1	.50
981	[3] 2.3	[2] 1.2	[1] 1.1	.48
982	[3] 2.4	[2] 1.3	[3] 1.1	.46
933	[3] 2.6	[2] 1.4	[3] 1.2	.46
1984	[3] 2.8	[2] 1.5	[3] 1.3	.46
1985	[3] 3.1	[2] 1.5	[3] 1.6	.52
1986	[3] 3.3	[3] 1.6	[3] 1.7	.52
1987	[3] 3.6	[3] 1.7	[3] 1.9	.53
1988	[3] 3.8	[3] 1.8	[3] 2.0	.53

[1] Estimate of PEMEX (Petroleos Mexicanos).
[2] Estimate of the Mexican Petroleum Institute (IMP).
[3] Estimate of CRS.

Note: Actual includes 5,000 bbl/d of imported products.

PEMEX has stated that Mexican oil exports would reach 1.1 million b/d in 1980 and remain at that level for two years, and IMP has projected oil demand for the same time priod. Production levels, therefore, can be estimated from the two data sources. For the period 1983 to 1988, it was more difficult to arrive at estimates. First, the IMP

[13] IMP is an independent government organization whose main purpose is to carry on technical and economic research in the energy area. IMP also publishes an annual volume to its *Energeticos* series which is a comprehensive study of Mexico's past, present and future energy picture.

provided estimates of oil demand through 1985, and CRS assumed that an increase in demand of 5.5 percent compounded annually was reasonable in the years 1986 to 1988. Second, CRS made estimates on oil production levels to 1988 based on two important factors: (1) the most likely amount of associated natural gas that Mexico realistically could absorb as a part of its projected energy demand and the amount that would be left for export, and (2) implications for Mexican development strategies. After arriving at estimates for oil production and internal demand, CRS computed the export potential for 1988.

OIL EXPORT POTENTIAL: ASSUMING NO GAS EXPORTS

The CRS projections for Mexican oil exports assuming "no gas exports" for 1978 to 1988 are summarized in Table 8. Two factors are dominant in estimating domestic demand and crude oil production in this case. First, Mexico's demand for oil changes significantly in this case because there is a concerted effort to substitute gas for oil products, particularly fuel oil. The extent to which Mexico can substitute gas for fuel oil is developed in the gas analysis section beginning on page 30. The estimates for substituting gas for oil were converted to Btu's (1032 per mcf) and then to barrels of oil equivalent (5,800,000 Btu's per barrel). The estimates were subtracted from the projected oil demand in the "gas exports" case in Table 7. For example, in 1988, substitution of natural gas results in a decrease in domestic demand for oil on the order of 400,000 barrels of oil per day.

Production of oil is also affected significantly in the "no gas export" case, because much of Mexico's oil is associated with large volumes of natural gas. Because of the high level of dissolved gas in Mexican oil, oil and gas are inevitably produced in tandem. Thus Mexico's ability to develop domestic demand for gas will limit the oil production rate, if gas is not exported or flared (see gas analysis section, page 30). CRS projects that Mexico's oil production in the "no gas export" case would be lower between 1983–1988 than in the "gas export" case. In 1988, the difference is significant. CRS estimates that Mexico is likely to produce 3.0 million b/d in the "no gas export" and 3.8 million b/d in the "gas export" case.

TABLE 8.—EXPORT PROJECTIONS FOR MEXICAN CRUDE OIL ASSUMING NO GAS EXPORTS[1]

[In millions of barrels per day]

Year	Mexican production	Mexican demand	Export potential	Export/production ratio
1977	1.1	0 9	0.2	0.18
1978	1.4	1.0	.4	.29
1979	1.8	1.0	.8	.44
1980	2.2	1.1	1.1	.50
1981	2.3	1.1	1.2	.52
1982	2.4	1.1	1.3	.54
1983	2.5	1.2	1.3	.53
1984	2.6	1.2	1.4	.54
1985	2.7	1.2	1.5	.56
1986	2.8	1.2	1.6	.57
1987	2.9	1.3	1.6	.56
1988	3.0	1.4	1.6	.53

[1] Estimate of CRS.

INTERNATIONAL MARKET FOR MEXICAN OIL EXPORTS

The most profitable market for Mexican oil exports is the United States, which is located near the Mexican oil fields (less than four day's steaming time from the Gulf Coast refineries) and which has a large demand for imported oil. It is in Mexico's economic interest to sell more of its oil to the United States market, but Mexico also wants to diversify its markets. To increase its market share in the short-term, Mexico has discontinued the third-quarter export price by 15 to 20 cents per barrel on the U.S. Gulf Coast.[14] Even with the discount, PEMEX still nets more profit with these sales to nearby U.S. refiners than it would from sales to Japanese or European markets because of the lower transportation cost.

Even if the landed price at the refinery of Mexican oil and Arabian light were equal, Mexican oil may be cheaper because of the complexity of oil purchase credit arrangements. The typical credit term for the purchase of crude oil is 60 days from the time crude oil is produced from the well. The faster a refiner can convert crude oil to saleable products, the lower the finance charge. Because the steaming time from the Persian Gulf to the U.S. Gulf Coast is nearly 11 times as long as from Mexico to the same destination (45 days versus 8 days), Mexican oil is effectively cheaper on a cash basis to Gulf Coast refiners than similarly priced Persian Gulf oil. A barrel of Mexican crude oil was sold on the Gulf Coast in the third quarter of 1978 for about $13.30 or less versus $13.45 for similar quality Saudi Arabian light. Alaskan North Slope (ANS) crude oil sells for $13.20–$13.25 at the Gulf with only 30-day credit, but it has a refining value of 38 cents per barrel less than Mexican Reforma crude.

One of the most important aspects of the Mexican oil export potential is that it represents one of the few new sources of light-to-intermediate crude oil at a time when world supplies of that type of oil are subject to production restrictions. U.S. refiners need and can use the Mexican oil, and Mexico is eager to sell it at close to world market prices. For example, 40 percent or 25,000 to 30,000 b/d of the sour crude oil currently being placed in the U.S. Strategic Petroleum Reserve storage is from Mexico and this could more than double to 70,000 to 80,000 b/d by March 1989. The higher tanker rates that are likely to prevail in the 1980's will almost certainly increase the Mexican price advantage. This is because transportation will represent a relatively higher fraction of the cost of other competing foreign and ANS crudes due to their longer haul distances.

Most of the tankers that carry oil from Mexico are currently limited to about 44,000 to 50,000 dwt because of draft limitations at the Mexican ports. In order to make greater use of cost-efficient Very Large Crude Carriers (VLCC's) in exporting of the Reforma crude, PEMEX is having a monobouy built in the Caribbean, off the Reforma Coast. VLCC's could be loaded from this facility by 1980. PEMEX is also planning to construct a terminal at Santa Cruz on the Pacific Coast of Mexico for tankers of up to 250,000 dwt. This terminal is being built primarily to facilitate oil exports to Japan and other Pacific nations.

[14] Petroleum Intelligence Weekly, July 17, 1978, p. 1.

The transportation cost of Mexican oil to the U.S. Gulf Coast is currently about 58 cents per barrel lower than for Saudia Arabian oil. Future increases in world scale rates, despite initially lower unit costs (a one-time reduction) resulting from the greater use of VLCC's, could raise this differential to $1.70 (in constant dollars) per barrel by the end of the century.

Mexico has stated on several occasions that its first export priority in determining recipients of its oil would be the developing countries of Latin America. With only Venezuela and Ecuador self-sufficient, the potential market for Mexican exports is high. Mexico is already exporting oil to Cuba, Israel, Spain, and the United States.

In order to make its crude oil competitive with Arab light in Europe, PEMEX is studying the possibility of back-haul use of VLCC's.[15] In this plan, the supertankers that are delivering North Sea crude to the Strategic Petroleum Reserve would then load Mexican crude oil for delivery to the Mediterranean.

Mexico recently concluded a crude oil swap arrangement with the Soviet Union. Mexico will supply Cuba with oil to replace oil that is now shipped to Cuba from the USSR. Soviet oil will then be sent to Spain to complete the PEMEX contract with that country. PEMEX has stated that it will supply 30,000 b/d to Cuba, a level which could eventually rise to 70,000 b/d and which will be reimbursable by the USSR.

OPEC AND MEXICO

Mexico's oil export policy is important not only for its own oil industry, but for the influence it may have on other oil producing states, particularly those who are members of Organization of Petroleum Exporting Countries (OPEC). Beginning in 1974, Mexican officials suggested that the country should join OPEC, at least as an observer. In May 1975, President Echeverria stated that Mexico would become a full member of OPEC. Since then, however, the policy has apparently changed, with Mexico now saying it will not join OPEC, although it would continue to follow OPEC prices.

Mexico would have little to gain by actually joining OPEC; in fact, it would have much to lose by doing so. Mexico currently receives the same benefits of high oil prices that the cartel members receive, while it retains its own independence of action. It does not have to abide by OPEC decisions on such matters as discount pricing and production cutbacks. As a member, Mexico would also be subject to any OPEC-induced production cutbacks which could harm its plans for obtaining development capital. Perhaps even more importantly, Mexico is aware that joining OPEC could jeopardize its trading status with the United States (see trade section).

Despite its great needs for foreign exchange, Mexico is aware of the price benefits it has reaped through OPEC control of the world price of oil. It is unlikely that Mexico would permit its exports to challenge the cartel's pricing structure, Mexico is far more likely to continue its policy of producing at those levels that will permit it to obtain prices that are close to world market levels.

[15] Petroleum Intelligence Weekly. September 25, 1978, pp. 5–6.

NATURAL GAS—DOMESTIC DEMAND: PRESENT AND FUTURE

Since 1965, Mexican demand for natural gas domestically has decreased in comparison to all its other energy sources (Table 9). In 1965, natural gas made up 30 percent of Mexico's total energy demand, and over the years it has gradually decreased in relative importance to the point where it meets only 22 percent of total demand (in 1975). The table shows that almost all of the slack in natural gas demand was filled by oil which increased in usage during the same ten year period from 54 percent to 60 percent of Mexico's total demand.

The main reasons for the shift in energy usage during the period were availability and certainty of supply. Mexico's gas production grew slowly but sporadically; in 1971 production actually declined and two years elapsed before 1970 production levels were reached again. Most Mexican gas is associated with oil. Because concentration ratios of gas to oil are different, not only for each oil well but also during the course of each well's life expectancy, production levels were uncertain. In addition, gas distribution systems, which include processing plants, gathering pipelines, transportation facilities, and end-use distribution pipelines, are capital intensive. The uncertain amounts of gas production and the level of required capital investment provided a disincentive for capital-short PEMEX to utilize fully its gas supply. Flaring of associated gas in the southern fields resulted.

TABLE 9.—HISTORICAL CONSUMPTION OF ENERGY IN MEXICO BY SECTOR, 1965-75

[Trillions of Btu]

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Residential:											
LPG	26.4	29.8	36.6	39.1	43.8	46.9	51.2	65.8	63.7	69.4	74.7
Kerosene	30.2	30.0	29.9	29.7	29.4	29.3	29.1	28.9	29.8	29.3	31.7
Natural gas	4.7	5.4	5.6	6.7	7.2	8.3	8.3	9.2	10.4	9.6	10.6
Electricity	7.2	7.8	8.9	9.9	11.3	12.6	14.3	16.0	18.1	19.8	21.8
Total	60.5	73.0	81.0	85.4	91.7	97.0	102.9	119.9	122.0	128.1	138.8
Commercial:											
LPG	5.3	5.6	5.7	6.8	7.0	9.3	8.3	10.2	8.6	12.5	13.5
Gasoline	.5	.5	.5	.5	.5	.6	.6	.6	.7	.7	.7
Kerosene	10.1	11.6	11.7	12.7	11.4	10.7	10.4	10.1	9.9	11.7	12.1
Diesel	3.5	3.8	4.1	4.5	5.1	5.5	5.8	6.4	6.7	7.8	8.5
Fuel oil	1.7	1.8	1.9	2.0	2.3	2.5	2.9	3 3.	2.6	3.3	3.6
Natural gas	1.5	1.8	1.9	2.3	2.4	2.7	2.8	3.1	3.6	3.6	3.6
Electricity	5.5	5.8	6.8	7.5	8.5	9.6	10.6	11.6	13.0	14.7	16.0
Total	20.3	30.9	32.6	36.3	37.2	40.9	41.4	45.3	45.1	54.3	58.0
Agricultural:											
Kerosene	9.9	9.7	9.5	9.6	9.8	9.6	9.3	8.5	9.3	8.9	8.8
Diesel	16.4	17.0	19.7	19.7	20.8	22.2	23.4	23.7	24.0	30.1	32.5
Electricity	2.7	3.1	3.6	3.6	4.1	4.8	4.8	4.8	5.8	7.2	8.2
Total	29.0	29.8	31.9	32.9	34.7	36.6	37.5	37.7	39.1	46.2	49.5
Industrial:											
LPG	9.9	14.4	14.8	14.8	15.1	13.3	12.6	12.8	14.6	16.5	16.6
Gasoline	2.3	3.2	1.7	2.8	1.6	2.3	1.9	2.0	2.2	2.2	2.2
Kerosene	12.5	13.0	13.2	13.2	13.3	13.8	13.9	14.1	14.2	14.8	15.1
Diesel	15.3	17.9	10.8	19.1	17.14	16.0	17.9	16.0	17.0	18.1	19.3
Fuel oil	99.7	100.1	112.4	109.0	119.3	114.6	126.3	131.4	131.7	171.0	207.3
Natural gas	134.9	154.6	174.4	181.6	208.0	228.2	237.9	243.8	257.4	268.0	247.0
Coal	40.2	41.8	46.2	50.1	50.3	57.7	68.3	72.5	80.4	100.9	104.9
Electricity	23.9	25.9	29.7	33.5	37.9	42.5	45.1	49.6	54.1	56.0	61.4
Total	338.7	378.9	412.2	424.1	462.9	488.4	523.9	542.2	571.6	649.5	673.8

Total Energy:											
LPG	63.3	70.8	76.3	80.6	84.3	86.0	88.6	106.1	103.1	112.9	120.6
Gasoline	186.0	203.4	224.7	239.8	258.5	278.0	297.1	320.6	357.1	371.4	378.0
Aviation fuels[1]	11.8	12.8	15.1	17.5	20.1	22.0	23.2	26.3	29.8	30.3	38.2
Kerosene	63.8	65.2	65.2	66.3	64.9	64.6	64.1	62.7	64.4	66.0	69.1
Diesel	116.7	129.2	139.0	155.6	174.2	189.5	197.5	218.9	249.3	291.0	346.2
Fuel oil	160.5	171.4	191.9	198.6	214.9	233.0	275.4	308.2	315.8	374.5	422.6
Asphalt	18.2	21.0	22.1	20.8	20.5	22.3	25.2	29.3	31.8	27.8	32.9
Lubricants	9.4	10.1	11.4	11.7	12.6	13.2	12.6	14.0	14.5	17.4	17.2
Greases	.4	.3	.5	.5	.4	.4	.4	.4	.5	.6	.5
Wax	3.4	3.2	3.6	3.4	4.0	3.9	3.9	4.8	4.2	4.8	4.7
Total oil	634.3	687.4	749.8	794.8	854.4	912.9	988.0	1,091.3	1,170.5	1,304.7	1,430.0
Natural gas[2]	351.3	366.2	413.5	406.6	389.4	413.5	434.6	459.9	498.0	532.0	539.8
Coal	40.4	42.0	47.0	52.1	52.9	60.6	70.5	75.5	83.2	103.8	107.5
Hydroelectric	86.4	99.5	100.5	124.1	133.0	148.0	142.7	152.4	160.8	150.4	150.1
Geothermal									1.8	4.4	4.9
Nuclear											
Total primary energy	1,112.4	1,195.1	1,318.8	1,377.6	1,429.7	1,535.0	1,635.8	1,779.1	1,914.3	2,096.2	2,232.3
Electricity	41.6	45.3	51.9	57.9	65.9	74.1	80.9	90.1	99.1	100.7	118.7
Total energy	1,154.0	1,240.4	1,370.7	1,435.5	1,495.6	1,609.1	1,716.7	1,869.2	2,013.4	2,205.9	2,351.0

[1] Includes aviation gasoline and jet fuel.

[2] Historical data contain values of gas used for reinjection; projected data contain 14 Bcf per year for reinjection.

Note: May not include refinery consumption of fuel oil; if so, annual consumption of fuel oil would be increased by approximately 10 percent.

Source: Energeticos, vols. I to IV, published by the Mexican Petroleum Institute, 1975–77.

On the other hand, Mexico's oil production grew consistently, albeit slowly, with production increasing each year during the same 1965–1975 period. Most important was, however, that any shortfall in domestic oil supplies could be satisfied more easily with imports than any shortfall in domestic natural gas supplies. Gas in its natural state could only be imported from the United States, but the United States experienced little growth in production during the early 1970's with production actually in decline since 1973. Importation of liquified natural gas (LNG) was unrealistic until the early 1970's and in any event, would have been much riskier and more expensive than importation of crude oil products.

In 1975, Mexican gas production was 790 billion cubic feet (bcf). Of that amount 247 bcf (45 percent) was used in the industrial sector, particularly in the following industries: steel, chemical, cement, glass, and mining and minerals. PEMEX used 195 bcf (36 percent), and power plants used 84 bcf (15 percent) to generate electricity. The residential and commercial sectors consumed the rest, 14 bcf (4 percent). Most of the balance, 250 bcf, was lost in distribution or flared.

Future gas demand in Mexico is difficult to project primarily because the Mexican Government is in a transition phase of possibly moving back towards greater dependence on natural gas. The main factor which has forced the Mexican Government to make new policy decisions on natural gas is that prolific oil areas in Mexico have a large concentration of natural gas which would have to be produced if Mexico is to meet its announced oil production goals. Mexico has four alternatives concerning the new supplies: (1) cut back on oil production goals, an unlikely alternative in the short term (to 1982) because Mexico needs the revenue from oil exports; in the long term (1983–1988), holding back oil production to avoid wasting large gas supplies is a real possibility; (2) use it domestically; (3) flare it, another unlikely and wasteful alternative since billions of cubic feet are at stake and Mexico has announced a strict energy conservation policy; or (4) export it.

Initially, in 1976 Mexico made the decision to continue to rely on an oil-based domestic development plan and to sell the excess associated gas to the United States. Toward this end, Mexico announced it would build an 847 mile, 48-inch pipeline from Cactus to Reynosa, which is about 100 miles from McAllen, Texas, where there was already in place a gas transportation system to the rest of the United States. The plan called for initial deliveries to be about 800 million cubic feet a day (mcf/d), gradually increasing to 2 bcf/d after processing facilities and compressors were installed and operating. On August 3, 1977, six U.S. gas pipeline companies, Tenneco, Texas Eastern Transmission, El Paso, Southern Natural Gas, Florida Gas Transmission, and Transcontinental Gas Pipeline, agreed with PEMEX officials to a Letter of Intent on the project.

In the fall of 1977, U.S. Government officials expressed reservations concerning the price of the Mexican gas. The price over the six-year life of the contract was pegged on a BTU basis to the prevailing price of No. 2 fuel oil delivered in New York harbor. This yielded $2.60 per mcf of gas at the time of the letter of intent. U.S. officials feared it

would automatically trigger a price increase in the price of imported gas from Canada, might jeopardize the pending natural gas legislation and would index gas prices to OPEC crude oil increases. Faced with U.S. intransigence on the price, PEMEX let the Letter of Intent expire December 31, 1977, without a formal agreement on the project.

POTENTIAL MEXICAN DOMESTIC DEMAND FOR GAS

Since the experience with the U.S. gas agreement, Mexico has been faced with the real possibility of no gas exports and having to consume all of its gas internally. Therefore, in order to assess Mexico's future demand for its gas, two polar cases have to be considered: (1) the case of gas exports, the scenario that Mexico had assumed for its policy planning until December 1977; and (2) the case of no gas exports with Mexico substituting gas for as much of its energy needs as possible and exporting instead the crude oil saved.

To assess the feasibility of the "no gas export" case, CRS examined the potential for substituting gas for the demand of other sources of energy. It was found that gas could be substituted primarily for fuel oil with limited substitution for diesel fuel and liquid petroleum gas (LPG). The substitution could occur in power plants generating electricity (a government controlled industry), in industry and in PEMEX's refineries, petrochemical plants and pipeline systems (in such uses as pumps and compressors). The small local distribution system and the lack of gas appliances will limit gas substitution in the residential and commercial sectors. As a result, substitution would be heavily concentrated in regions around Monterrey, Mexico City, and oil-producing areas. The CRS projections for gas demand in Mexico during the period 1975 to 1988 are summarized in Table 10.

TABLE 10.—PROJECTED GAS DEMAND IN MEXICO

[Billions of cubic feet]

Year	Residential	Commercial	Industrial		PEMEX (petroleum sector)		Powerplants		Total annual demand		Total demand per day	
			Case 1: Exports	Case 2: No exports	Case 1: Exports	Case 2: No exports	Case 1: Exports	Case 2: No exports	Case 1: Exports	Case 2: No exports	Case 1: Exports	Case 2: No exports
1975	11	4	247	247	195	195	84	84	541	541	1.5	1.5
1976	12	4	266	266	211	211	35	35	528	528	1.4	1.4
1977	13	4	287	287	228	228	35	35	567	567	1.5	1.5
1978	14	5	311	311	247	247	36	36	613	613	1.7	1.7
1979	15	5	334	334	267	286	39	190	660	830	1.8	2.3
1980	16	6	361	361	289	325	36	226	708	934	1.9	2.6
1981	17	6	383	390	294	364	34	244	734	1,021	2.0	2.8
1982	19	7	407	420	299	403	42	293	774	1,142	2.1	3.1
1983	20	7	432	454	304	442	44	364	807	1,287	2.2	3.5
1984	22	8	459	489	309	481	46	400	844	1,400	2.3	3.8
1985	24	9	487	529	315	521	60	514	895	1,591	2.5	4.4
1986	26	9	517	571	320	564	66	571	938	1,741	2.6	4.8
1987	28	10	550	615	325	609	74	623	987	1,885	2.7	5.2
1988	31	11	584	662	337	659	82	669	1,045	2,032	2.9	5.6

Source: IMP and CRS.

CASE 1. GAS EXPORT

Residential and commercial gas demand in both cases is assumed to grow at the 1965–1975 historical rates of 8.5 percent annually and 9.1 percent annually, respectively.

Gas use in the industrial market is assumed to grow at the rate of 7.8 percent annually through 1980, this rate projected by the Mexican Petroleum Institute.[16] Thereafter, conscious efforts on the part of the Mexican Government to lower internal gas usage to free gas for export are assumed to result in a return to a demand growth level no higher than the historical trend of 6.2 percent annually for the remainder of the study period.

Likewise, the use of gas in the petroleum sector (PEMEX) is projected to grow at those rates (8.2 percent) forecast by IMP through 1980 when the Mexican Government makes an effort to restrict gas usage and PEMEX returns again to a more constrained level of gas use, gradually approaching the historical level (1.7 percent).

The power plant sector, based on the IMP *Energeticos* series,[17] shows a restrained use of gas for power generation and slow growth.

CASE 2. NO GAS EXPORT

The industrial sector is forecast to grow at 7.8 percent annually, based on the *Energeticos* series. But CRS expects this rate to continue through 1988 in this scenario as the Mexican Government makes a conscious effort to foster internal gas use. Such a policy could take the form of offering low priced gas to industrial users or offering a tax credit to industries locating near a gas pipeline.

Energy use in the PEMEX sector is assumed to increase at a rate of 8.2 percent annually, the IMP estimate. In addition, CRS assumes in the "no gas export" case that PEMEX over five years (1979–1984) will phase-in a conversion program that will change facilities from oil to gas burning. The conversion program will result in a 15 percent rate of substitution of gas for oil uses.

The power plant "no export" demand for gas was constructed based on IMP fuel forecasts for this sector.[18] Ninety percent of the annual incremental fuel demand for the two alternate fuels (oil, coal) thought prone to gas substitution was allocated instead to natural gas. No gas substitution was assumed for diesel, geothermal, hydroelectric, or nuclear.

The 90 percent substitution rate of gas for oil and coal is based on what occurred in the U.S. power plant sector during the 1960–1970 time period. This phenomenon occurred in the United States because gas was plentiful and low in price, adequate incentive to use natural gas for power generation. Hence, Mexico should be able to do at least as well by combining government control and the low price incentive.

SUPPLY-DEMAND BALANCE: WITH GAS EXPORTS

CRS projections for gas production, demand, and export potential under the "gas export scenario" are summarized in Table 11. Gas production in Mexico is divided into two types: non-associated gas

[16] Energeticos, The Mexican Petroleum Institute, Volume II, 1976. p. 172 and 174.
[17] Energeticos, The Mexican Petroleum Institute, Volume IV, 1977. p. 207.
[18] *Ibid.*

produced from fields containing only gas, and associated gas produced from fields containing oil and gas. Current non-associated gas production is .8 bcf/d. CRS estimates this level will remain constant through 1988, even though Mexico could increase production beyond this point. Mexico must first find profitable uses for the large amounts of gas associated with oil in the Southern oil producing regions before increasing non-associated gas production. The CRS estimate for associated gas production is heavily dependent on the accuracy of the estimates for oil production, already discussed, and for the gas to oil ratio (GOR), which is currently 1200 cubic feet per 1 barrel of oil produced. CRS believes the GOR will remain at 1200 cubic feet per 1 barrel of oil until 1980 and gradually rise to 2000 cubic feet per 1 barrel of oil by 1988 as fields with higher GOR's are brought on production, and as maturing fields produce relatively more gas with the oil.

TABLE 11.—PROJECTED MEXICAN GAS PRODUCTION, DEMAND AND EXPORT POTENTIAL

CASE I: WITH GAS EXPORTS

[Billion cubic feet per day]

Year	Crude oil production (million barrels per day)	Gas to oil production rate (cubic feet per barrel)	Associated wellhead gas production	Non-associated wellhead gas production	Total gross production	Vented, loss and reinjection	Extraction loss, 8 percent	Net available gas	Domestic demand	Exportable gas
1978	1.4	1,200	1.7	0.8	2.5	0.6	0.2	1.7	1.7	0.0
1979	1.8	1,200	2.2	.8	3.0	.2	.2	2.6	1.8	.8
1980	2.2	1,200	2.6	.8	3.4	.2	.3	2.9	1.9	1.0
1981	2.3	1,350	3.0	.8	3.8	.2	.3	3.3	2.0	1.3
1982	2.4	1,400	3.4	.8	4.2	.3	.4	3.7	2.1	1.6
1983	2.6	1,500	3.9	.8	4.7	.3	.4	4.0	2.2	1.8
1984	2.8	1,600	4.5	.8	5.3	.5	.4	4.4	2.3	2.1
1985	3.1	1,700	5.3	.8	6.1	.4	.5	5.2	2.5	2.2
1986	3 3	1,800	5.9	.8	6.7	.4	.5	5.8	2.6	3.0
1987	3.6	1,900	6.8	.8	7.6	.6	.6	6.4	2.7	3.7
1988	3.8	2,000	7.6	.8	8.4	.8	.7	6.9	2.9	4.0

After obtaining the total gross production estimate, losses due to flaring, reinjection and extraction are subtracted to obtain an estimate of the net available gas. The domestic demand for the "gas export" case is then subtracted to get the exportable gas estimate. When gas exports reach the 2.0 to 2.5 bcf/d range, Mexico will have to increase its pipeline capacity in the southern region if it is to accommodate further gas exports.

SUPPLY-DEMAND BALANCE: WITHOUT GAS EXPORTS

CRS projections for gas production, demand, and export potential under the "no gas export" scenario are summarized in Table 12. The critical variable in this scenario is Mexico's ability to convert fuel oil use to gas use. CRS assumed Mexico for conservation purposes would produce only as much gas as it could consume; Mexico, it is assumed, will not burn off, or flare, excess gas. With so much of Mexico's gas associated with oil, oil production would certainly be curtailed to avoid flaring gas. Mexico in the next several years cannot consume all the gas that would otherwise be produced. In the "no export" case, CRS believes that Mexico would have to cut back

its 1988 oil production projection from 3.8 to 3.0 million b/d, to avoid an excess gas supply. A 1988 production goal of 3.0 million b/d still means that from 1978 to 1986 some of Mexico's non-associated wellhead capacity will most likely have to be "shut in" in order to keep the unusable supply to a minimum.

TABLE 12.—PROJECTED MEXICAN GAS PRODUCTION DEMAND, AND EXPORT POTENTIAL

[Billion cubic feet per day]

CASE 2: WITHOUT GAS EXPORTS

Year	Crude oil production (million barrels per day)	Gas to oil production rate (cubic feet per barrel)	Associated wellhead gas production	Nonassociated wellhead gas production	Total gross production	Vented, loss and reinjection	Extraction loss, 8 percent	Net available gas	Domestic demand	Exportable gas
1978	1.4	1,200	1.7	0.8	2.5	0.6	0.2	1.7	1.7	----------
1979	1.8	1,200	2.2	.5	2.7	.2	.2	2.3	2.3	----------
1980	2.2	1,200	2.6	.4	3.0	.2	.2	2.6	2.6	----------
1981	2.3	1,300	3.0	.3	3.3	.2	.3	2.8	2.8	----------
1982	2.4	1,400	3.4	.3	3.7	.3	.3	3.1	3.1	----------
1983	2.5	1,500	3.8	.3	4.1	.3	.3	3.5	3.5	----------
1984	2.6	1,600	4.2	.4	4.6	.4	.4	3.8	3.8	----------
1985	2.7	1,700	4.6	.6	5.2	.4	.4	4.4	4.4	----------
1986	2.8	1,800	5.0	.7	5.7	.4	.5	4.8	4.8	----------
1987	2.9	1,900	5.5	.8	6.3	.6	.5	5.2	5.2	----------
1988	3.0	2,000	6.0	.8	6.8	.7	.5	5.6	5.6	----------

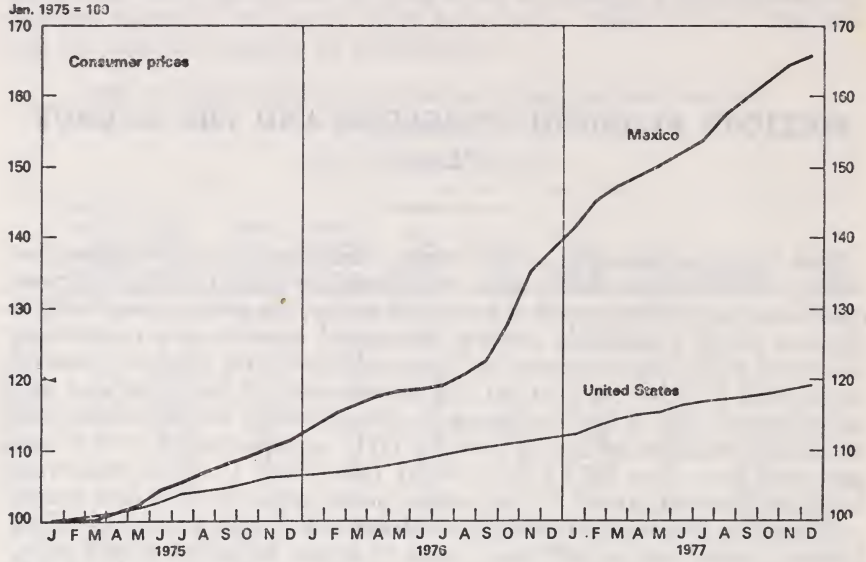
MEXICO'S ECONOMIC PROBLEMS AND THE ENERGY PLAN

The Mexican economy is recovering from the economic difficulties which led to the peso devaluation of September 1976. In 1978, business confidence is growing, credit is becoming easier, the government budget appears under reasonable control, industrial expansion is underway, the value of the peso appears to have stabilized, and there is renewed confidence founded in part on the expectation of large oil and gas deposits and also in large measure on the austerity measures adopted by the government of Lopez Portillo. GDP is expected to grow 5 percent this year after 1977's 2.8 percent (see Chart 1). Most observers feel a real growth rate of 6–7 percent is possible for the next four years.

However, Mexico has serious problems which will adversely effect Mexico's economy in 1978 and years to come. Inflation is still high, about 30 percent in 1977, with about 15–20 percent projected in 1978. Some experts feel Mexico in the near future will not be able to reduce inflation below this level despite President Lopez Portillo's stated objective of a rate near or at that of the United States (see Chart 3). Inflation in Mexico has many components, most of which are beyond the scope of this paper. Three can be identified: First, domestic demand for all goods exceeds supply because Mexican productive capabilities cannot keep up with Mexico's extremely high rate of population growth; second, the extent to which imports might satisfy the Mexican domestic demand is constrained because of trade barriers to imports, which in turn results in higher prices; and finally, organized labor's demands for compensation due to inflation have resulted in large wage adjustments, increased incomes and therefore demand for limited domestic products.

Chart 3

Inflation compared: the two lines that Mexico watches most closely.



Source: *Euromoney*, April 1978, p. 27.

UNEMPLOYMENT

Although employment data are not available, estimated unemployment combined with underemployment are high, with some estimates approaching 50 percent. The percentages are not likely to recede. The problem stems from the country's rapidly increasing population (currently 3.4 percent per year), combined with the failure to create enough jobs for the 700,000 new entrants annually to the labor force. If the population were to continue to grow at 3.3 percent, the approximate rate for the past 15 years, then by 2000 the population would be about 135 million or more than double the current 65 million. If the economy were to return to the six–seven percent a year growth in GDP, industry could provide approximately 150,000 new jobs a year.[19] As a result, even if 150,000 jobs were provided elsewhere, less than half of the new entrants coming into the work force each year would find a job.

Overcrowding in the rural sector has resulted in a large portion of the rural population migrating to cities, imposing huge strains on those areas. Mexico City, for example, has a population of 13 million and is growing annually by nearly 750,000 people.

One reason for the rural migration to the cities is the performance of Mexico's agricultural sector. Mexican agriculture contributes 9 percent of GDP but employs an estimated 33 percent of the labor force. The agricultural sector has contributed to the unemployment and underemployment problem because agricultural output has increased recently at a rate much lower than its historical rate. Between 1940 and 1965 output grew an average of 5 percent annually, but between 1965 and 1976 the rate of growth was only 2.5 percent,

[19] Gordon, *op. cit.*, p. 7.

significantly below the national population rate of growth of 3.3 percent. Some farmland is overworked, creating lower productivity and underemployment, while other lies idle. The farmland cannot fully absorb new entrants into the work force.[20]

Factors bringing down the rate of output include the following. First, there were uncertainties about land tenure. Since the 1910 revolution, land redistribution or land reform has been an issue that all Mexican Presidents have had to deal with. Past Presidents of Mexico have placed different emphasis on land reform. Some have emphasized land development and productivity before land redistribution. But others like President Echeverria have made land redistribution the primary goal. With land seizure a possibility at any time, landowners slowed the rate of investment.

Second, consistently bad weather conditions in the form of droughts have produced poor crop yields over a number of years.

Third, the State Marketing and Price Stabilization Board (CONASUPO) practiced policies which discouraged investment to improve yield. CONASUPO was created to buy staple foodstuffs from farmers at guaranteed prices and sell the produce in CONASUPO shops to urban dwellers at sometimes subsidized prices. Politicians too often succumbed to pressure to keep urban food prices low. In order to keep the budget somewhat balanced the guaranteed prices were also kept low, resulting in little or no profits for the farmers, who then cut back on their production.[21]

To address the agricultural problems, President Lopez Portillo raised farm prices in November 1976. Even though he is implementing Mr. Echeverria's land reform program, he has not offered any further land distribution plans. In 1977, overall agricultural production increased about 4 percent in volume. Increased productivity will make it easier to meet the domestic demand for foodstuffs from domestic farms, but chances are it will not create new jobs. Increased productivity might also mean creating a surplus of foodstuffs for export contributing positively to Mexico's balance of payments.

BALANCE OF PAYMENTS

Mexico has had for many years a trade deficit and a current accoutn deficit in its balance of payments. The government essentially decides to draw on foreign resources to increase the rate of economic development beyond what could have been achieved by relying exclusively on national savings.

Mexico's current account deficit for the last several years has been less than the trade deficit because of the surplus in the service items, mainly from tourism and border transactions (purchases by residents on both sides of the northern border). Except for an improvement of $220 million in 1971, Mexico's balance of trade has gradually deteriorated in the six years between 1970 and 1976. In 1977, however, Mexico's current account deficit improved by almost 50 percent to $1.6 billion.[22] Reasons for this include devaluation, restricted govern-

[20] *Ibid.*
[21] *Ibid.*
[22] Indicators Economics, Oct. 1977, Vol. IV, No. 11, Table IV-1.

ment expenditures, reduced domestic demand and petroleum exports. The 1978 current account deficit is expected to increase to $2–2.5 billion, mainly because imports are projected to rise again.[23]

EXTERNAL DEBT

Since 1965, the ratio of Mexico's cost of servicing its external debt to its export earning has consistently exceeded 20 percent and has twice gone beyond 25 percent, a high ratio. In the 1970's Mexico's external foreign debt in the public sector skyrocketed from $3.6 billion in 1971 to about $20 billion in 1977, when Mexico's debt service exceeded $4 billion. In 1976, Mexico approached the International Monetary Fund (IMF) for a loan. This was granted only with strict conditions attached to it. Public-sector deficits as a percentage of GDP were to fall from the 8.7 percent reached in 1976 to 5.7 percent in 1977, 3.7 percent in 1978, and 2.2 percent in 1979. New foreign debt was to be limited to $3 billion per year in 1977 and in 1978. Targets were established for money supply levels. Other conditions included elimination of foreign exchange controls, but with some restriction on trade protection.[24]

Currently banks are eager to lend to Mexico both because of confidence in the government of Lopez Portillo and the presence of large quantities of oil and gas. In 1978, Mexico will borrow $8 billion externally of which $5 billion will repay debt maturing this year and $3 billion will be new money. Terms for the new debt are expected to be more favorable as confidence in the country's economy increases.

FOREIGN INVESTMENT

Another way to raise capital investment in Mexico is to encourage foreign investment. Traditionally, Mexico has regarded foreign investment as the least desirable alternative to financing domestic investment. The tradition was translated into law when the Echeverria administration passed legislation clarifying the rules for foreign investment. The laws permit foreign direct investment under regulation, if it does not compete with domestic investment and if it brings technology into the country which would otherwise be unobtainable. In addition, at least 51 percent of equity in any business venture must be Mexican-owned.[25]

One expert says there were two negative effects from the 51 percent requirement. First, it spreads Mexican capital and enterprise more thinly over the economy. Second, it has the effect of diminishing the inflow of foreign capital by restricting to 49 percent foreign investors share in any one venture.[26] In the manufacturing sector, for example, the share of foreign participation in total private fixed investment has slipped from five percent in the 1960's to four percent in the early 1970's and to three percent in 1976.

Others, however, maintain that the foreign investment laws have not greatly influenced the situation. The American Chamber of Com-

[23] Foreign Economic Trends and Their Implications for the United States, prepared by the U.S. Foreign Service. June 1978, p. 28.
[24] Gordon, *op. cit.*, p. 19.
[25] Romo, Jorge, Foreign Investment and the Law. Mex.-Am. Review. March 1975, p. 83.
[26] Opi, Redvers, The Mexican Economic System. Appeared as testimony in Hearings. U.S. Congress. Senate Joint Economic Committee. Subcommittee on Inter-American Economic Relationship. Recent Developments in Mexico and their Economic Implications for the United States. Hearings. 94th Congress, 1st Session. January 17 and 25, 1977. Washington, U.S. Govt. Print. Off., 1977, p. 37.

merce of Mexico, whose membership represents the major part of U.S. direct private investment in Mexico, believes the Mexican investment laws have produced some negative reactions, but, on balance, foreign investors have found that the laws are tolerable and that reasonable profits can still be made in spite of controls and restrictions.[27] The organization predicts that the same factors which traditionally made Mexico attractive to foreign investors will prevail—freedom from exchange controls, political stability, a growing domestic market, and strong government investment in infrastructure to support industrial development. Despite those advantages, Mexico is not experiencing any upturn in investment from the United States, which accounts for more than 70 percent of foreign holdings. In the first quarter of 1978, Mexico's central bank reported new private foreign investment in Mexico totaled only $38.4 million. Total foreign direct investment is a declining amount in Mexico's long-term capital account. In the 1960's, it averaged 34 percent of the net long-term capital inflow and was 40 percent in 1970, after which it declined steadily to 9.3 percent in 1975.[28]

Could Mexico use foreign investment? To answer the question, it is necessary only to know that Mexico is investing 20 percent of its GDP, less than $20 billion, in an economy that cannot come close to creating the hundreds of thousands of extra jobs required to absorb the new entrants into the work force. It was reported that Mexico's private sector examined the role of foreign capital in Mexico. The study assumed that domestic savings could be raised from 17.5 percent to 25.0 percent of GDP by the year 2000.[29] At that level, if Mexico hopes to provide enough jobs for its people, international borrowing will have to increase three-fold (as a percentage of GDP) in the next 25 years.[30] Further the need for foreign direct investment would increase seven-fold (as a percentage of GDP) because the cost of servicing the projected foreign debt would limit the amount that could be borrowed.[31]

President Lopez Portillo has not shown any evident interest in modifying the foreign investment laws, but the administration has demonstrated a flexible interpretation. With the expected increased foreign exchange earnings from increased petroleum and possibly natural gas exports, and its ability to borrow against these potential exports, Mexico evidently has decided there is no present need to change its policies on foreign direct investment.

OIL AND NATURAL GAS REVENUES: ECONOMIC POLICY CONSIDERATIONS

Mexico has not yet announced a policy for incorporating the oil and gas revenues into an overall plan for economic development. But in a recent interview, Romero Kolbeck, the Director-General of Banco de Mexico, talked about the impact of oil on the economy and how the revenues from oil and perhaps gas would be treated. He stated:

> In the future, oil will play a major role and will provide Mexico with additional resources that can be invested not only in the field of energy, but in many other

[27] Wichtrich, Al. R. Appeared as testimony in Hearings. U.S. Congress. Senate. Joint Economic Committee. Subcommittee on Inter-American Economic Relationships. Recent Developments in Mexico and their Economic Implications for the United States. Hearings, 94th Congress, 1st Session. January 17 and 24, 1977. Washington, U.S. Govt. Print. Off., 1977, p. 65.
[28] Opi Redvers. *op. cit.*, p. 36.
[29] Opi. Redvers. *op. cit.*
[30] *Ibid.*
[31] *Ibid.*

sectors that will provide employment. We are determined not to allow the growth of any one single sector or product to distort the rest of the economy and possibly hinder our long-term development. To that end, the foreign exchange derived from oil exports will be channelled into productive investment in fishing, agriculture, industrial activities and other sectors, thus avoiding the export of capital from Mexico.[32]

In response to the same questioning, David Ibarra Munoz, the Director General of National Financera, stated:

We want to devote part of the resources to increase production of petrochemicals and to export more. And also we want to use these resources to open up, as we have been doing, new regions for development. We want to develop new port facilities, and so on, in order to achieve a balanced growth in industry. So we intend to devote the petroleum resources to key sectors of the economy; that's to say that with the petroleum exports we will have greater freedom of action for a public policy of growth. [33]

From the above comments, it seems likely that Mexico will not allow its oil and gas expenditures and revenues to dominate its whole economy. Mexico already has a set of social goals against which decisions will have to be made on how to allocate the revenues. The following are some of the long-run planning goals of the Mexican Government:

A long term commitment to diversify the Mexican economy as exemplified by former President Echeverria's support of industrial growth policies.

A long term commitment to encourage population redistribution away from the present industrialized central areas to less well developed regions by creating employment wherever possible outside of the Federal District.

To invest in the agricultural sector in an effort to increase productivity.

To invest in tourism as a way to create jobs requiring little skill and to encourage the growth of support sectors of the economy.[34]

As a result, it is likely that the Mexican Government will use some of the revenues generated by oil and possibly gas to create employment in the agricultural and the tourism sectors. Because the past administration has supported expansion of industry such as the steel industry, this sector will probably also receive funds.

If the PEMEX policy of development is followed, it seems unlikely that the Mexican government would use the oil revenues to pay off its foreign debt in the short term. Mexico has agreed with the International Monetary Fund to limit foreign borrowing to $3 billion per year. Thus, tradeoffs exist, in terms of using foreign capital, between investing in PEMEX's plan and other government development programs. This is supported by comments made by David Ibarra Munoz who stated that the debt would not be decreased this year, but that it would again be at the $3 billion limit of the IMF "due to the fact that we have to devote very important resources to the PEMEX project." [35] Apparently the government will not lower spending in other sectors to fund the PEMEX projects, but will balance spending in all sectors. This is a short-run measure. In the future the debt is expected to be reduced. Munoz stated:

[32] "The Future of Mexico," A Supplement to Euromoney. April 1978, p. 6.
[33] *Ibid.*
[34] Gordon D. op. cit., pp. 18-31.
[35] Euromoney, op cit., p. 67.

One of our goals is to diminish the weight of the external debt, as well as to reduce the deficit in the balance of payments and government expenditure. We will try to do that. Of course, the exports of petroleum products and gas will make that easier.[36]

This statement is consistent with the policy of increasing expenditures now in order to encourage growth while paying later with anticipated oil money and with increased exports.

OIL AND GAS REVENUES: ITS ECONOMIC IMPACT

Oil revenues are already a major factor in the economy, earning approximately $1 billion in foreign exchange in 1977, and will probably double that in 1978. In 1978, petroleum exports will account for over 30 percent of total exports compared with 22 percent in 1977.

The substantial growth in the petroleum industry resulted in its rising from 3.4% of GDP in 1960 to 5% in 1976 (Table 13). But the major sectors of the economy continued to be commerce, manufacturing, and services.

Mexico's steadily rising oil and gas resource base will have a significant effect on the Mexican economy in the future. In order to measure the potential impact of increased oil and gas output on the economy, CRS has postulated two cases for production for 1988.

The two cases are based on specific assumptions in regard to oil and gas. These are derived from data presented in earlier chapters. Case 1, as shown in table 8, on page 24, assumes petroleum production will rise from 1.4 million b/d in 1978 to 3.8 million b/d in 1988. Domestic demand for oil will increase from 1 million b/d to 1.8 million b/d, resulting in an increase in exports from 400,000 b/d to 2 million b/d.

Natural gas production, in this case, will increase from 2.5 bcf/d to 8.4 bcf/d during this same period. The gas production figure is comprised of both associated and non-associated gas. The latter was taken at 800 million cf/d throughout the 1978–88 period. The associated gas production was computed using a rising gas to oil production ratio (1200 cubic feet per barrel (cf/bbl) up to 2000 cf/bbl). In addition, gross production was adjusted for gas vented, lost, or reinjected. As a consequence, net production was projected to increase from 2 billion cf/d in 1978 up to 6.9 billion cf/d in 1988. It was further assumed that a gas purchase agreement was signed by the U.S. and Mexico in early 1979, with the pipeline ready by September of that year, and gas flow starting in October 1979. Gas exports would thus rise from 800 million cf/d in 1979 to 4 bcf/d in 1988.

TABLE 13.—GROSS DOMESTIC PRODUCT BY MAJOR SECTORS, MEXICO, 1960, 1973, 1976

Sector	Percent of GDP		
	1960	1973	1976
Agriculture	15.8	10.1	8.9
Commerce	30.8	31.2	30.5
Construction	4.0	5.1	5.0
Electricity	1.0	1.9	2.2
Manufacturing	19.0	22.9	22.9
Mining	1.5	.9	.8
Petroleum	3.4	4.1	5.0
Services	21.2	20.3	20.8
Transportation and communications	3.3	3.5	3.9
Gross domestic product (B pesos at constant 1960 prices)	150.5	354.1	398.7

Source: "Mexico", United States $1,200,000,000 credit facility, Oct. 7, 1977, p. 15.

[36] *Ibid.*

In Case 1, investment in oil and gas development was taken as stated in the PEMEX 6-year plan for 1978–82. For the 1983–88 period, investment was assumed at $16 billion, with the bulk of the expenditures early in the period because of the lag between investment and production. It was further assumed that most of the money would go for development and for the expansion of the petrochemical sector. No new refinery capacity was considered for the 1983–88 period. Approximately 35 percent of the investment over the 1978–88 period was assumed to be from foreign sources.

Case 2, on the other hand, followed the PEMEX investment plan through 1982, with limited investment in the petroleum sector after that date. This case assumes that no agreement on gas exports is reached with the United States. As a consequence, only enough gas is produced to meet the needs of the domestic economy. Natural gas net production thus rises from 2.5 bcf/d in 1978 to a high of 5.6 bcf/d in 1988 (see Table 12, on page 34). Crude oil output is also reduced somewhat because of the high proportion of gas produced in association with oil, and because gas would substitute for domestic fuel oil use. As a result, crude oil production only rises to 3 mb/d by 1988 (see Table 8, on page 24).

Economic impacts

The two cases outlined above were analyzed using the Wharton Econometric Forecasting Associates Mexican model in an effort to determine the economic impacts on the Mexican economy.

In each of the two cases, the CRS assumed that the real price for both oil and gas would remain constant to 1988. The current dollar figures for oil exports used by the model were developed by escalating the real price ($13.20) at the projected U.S. inflation rate. The latter were taken from the U.S. Wharton model. Natural gas exports were taken at a real price of $2.60; this was also escalated at the U.S. rate of inflation. Domestic Mexican consumption of oil and gas is subsidized, in a sense, by sales at prices below the world market price, although presumably above production costs. The current Mexican domestic oil price is approximately $6.50 per barrel.

The results of our model runs are shown in Table 14. It is apparent from those numbers that the 1988 Mexican economy resulting from the export of 2 million b/d of oil plus 4 bcf/d of gas, versus that resulting from exports of 1.6 million b/d of oil only, is somewhat stronger, but not significantly so (5 percent higher GDP). As one would expect, the petroleum sector originates a larger share of GDP in Case 1 than in Case 2, as does electricity.

TABLE 14.—ECONOMIC IMPACT IN MEXICO OF ALTERNATIVE ENERGY SCENARIOS [1]

Economic indicators	1978	1983		1988	
		Case 1	Case 2	Case 1	Case 2
Gross domestic product (billion 1960 pesos)	435	598	601	833	798
GDP by sector of origin (percent):					
Agriculture	9	7	7	6	6
Construction	5	5	5	6	6
Electricity	2	2	3	3	3
Manufacturing	24	24	24	24	24
Mining	1	1	1	1	1
Petroleum	6	9	8	10	8
Trade	29	29	29	29	30
Transportation and communication	4	4	4	3	4
Other	20	19	19	18	18
GDP implicit price deflator (1960=1)	4.8	9.5	9.8	17.5	18.7
Inflation rate (percent)	20	12	13	13	14
Consumer Price Index (1960=1)	4.2	8.5	8.8	16.1	17.4
Per capita disposable income (thousand 1960 pesos)	4.8	5.5	5.6	6.7	6.4
Gross fixed investment (billion 1960 pesos)	93.7	138.5	138.7	208.4	200.4
Employment (million workers)	18	21	21	25	24
Balance on current account (billion dollars)	−2.1	−1.3	−2.5	+3.5	−6.0
Public external debt/GDP	24.4	13	14	5	11
Index—Average annual exchange rate (1960=1)	1.8	2.0	2.1	2.5	2.9

[1] Case 1 projects crude oil exports at 2,000,000 bbl/d in 1988, with natural gas exports at 4,000,000,000 ft³/d. Total output in that year is estimated at 3,800,000 bbl/d of oil and 8,400,000,000 ft³/d of gas. Case 2 projects 1988 crude oil exports at 1,600,000 bbl/d, with all natural gas produced being used within the country. Total output in 1988 is estimated at 3,000,000 bbl/d of oil and 6,800,000,000 ft³/d of gas.

Case 1 also has a lower tendency toward inflation, a positive balance of payments (vs. a negative balance in Case 2), and less external debt per peso of GDP. It also generates 4 percent more disposable income per capita, as well as 4 percent more investment and employment.

If the government's goal, as noted earlier in this chapter, is to reduce external debt and the balance of payments deficit, the export of oil and gas would be beneficial. Although the expansion of the petroleum industry to the levels contemplated will require the importation of large quantities of capital goods such as machinery and other equipment, the level of exports should be more than adequate to compensate.

A potential difficulty, however, might be the need to import more food than at present because farmers have been leaving the land to work in the oil fields and factories, and farm productivity has not increased sufficiently to balance the loss. It had been estimated that the country could be importing an estimated $3 billion in food by 1982.[37]

In either case, the inflation rate stays in the double digit range, while employment only rises by 1 million people in Case 1 compared with Case 2. The employment increase is close to 39 percent between 1978 and 1988 under the export scenario. Such an increase would be helpful but a long way from solving the problem in relative terms, although petroleum revenues are clearly a positive contributor to the solution. In 1976, an estimated 28 percent of the Mexican population of 62.3 million were employed. Assuming the 1988 population at 94.1 million (3.4 percent/yr. growth), employment under Case 1 assumptions would comprise 40 percent of the population. A lower population growth rate would result in a lower unemployment rate.

Although there are no labor force or unemployment data available for the country, the substantial increase in employment postulated above would have a minor impact on the unemployment rate in 1988.

[37] "Mexico Plans to Use Oil to Foster Development and Create Jobs", Business Latin America, April 12, 1978, p. 155.

At present an estimated 46 percent of the population is under 14 years of age,[38] implying a substantial increase in the 1988 labor force. This labor force increase will probably more than balance the increase in jobs. Thus, unless employment is substantially above our projection, the country could be losing ground despite the expansion of the economy. In a very real sense, Mexico is sitting astride a population time bomb.

Under our Case 1 assumptions, GDP per capita will increase 36 percent compared with 1978. Whether this substantial gain will correct the maldistribution of income by regions and groups is unknown. It may prove difficult, however, to control development so that the lesser developed regions receive a greater share of investment, particularly in view of the need to invest where the oil occurs. In addition, the relatively high technology of the oil industry may force an even worse income distribution pattern than currently exists. That is, wages and salaries for the more highly trained may rise substantially, but income for the majority may remain at or below the subsistence level.

In general, the impacts of the oil boom will be determined by government policy. It does appear, however, that the major problems facing the Mexican government today will still be there in 1988, regardless of the level of petroleum output. Inflation will still be high, income distribution and geographic development will still be unbalanced, unemployment will still be high, and the country will still have difficulty producing domestically all its foodstuffs. To an extent, the continuation of these problems is simply an indication that 10 years is not a very long time in the life of an economy.

[38] Gordon, *op. cit.*, p. 4.

IMPACT OF MEXICAN OIL AND GAS ON U.S. ENERGY POLICY

As recently as 1947, the United States was a net oil exporter. Since the late 1960's, however, U.S. demand has increased much faster than has domestic production and as a result, the United States now imports close to half of the oil that it uses.

Demand for natural gas has also increased rapidly in the past two decades because it was cheap, convenient, and clean-burning. It became the choice fuel and demand rapidly outstripped supply. Except for gas from Canada and a small amount of liquefied natural gas from Algeria, virtually no natural gas was imported.

When domestic gas production began to drop in 1973, demand remained high and resulted in severe and widespread shortages with considerable economic dislocation. Gas production has since dropped to 1968 levels.

To a large extent, these gas shortages were offset by imported oil. The dramatic growth in imports stimulated new interests in expanding domestic petroleum production and increasing the use of coal, hydro, geothermal, and nuclear power. If these attempts to produce domestic energy fall short of demand, as seems likely for the remainder of this century, imports will still be necessary and may actually increase in volume. Some of the oil and gas that will be needed could come from Mexico, which could have an exportable surplus of both.

The amount of imported oil and gas needed by the United States until 1988 has been the subject of numerous studies. In one such study, CRS estimated that oil imports—crude oil and oil products—are projected to be from 7.2 million b/d in 1976 to 10 million b/d in 1980, 11.8 million b/d in 1985, and 12.5 million b/d by 1988. The strategic oil storage program is projected to add another 0.4 million b/d in 1980 and 0.3 million b/d in 1985. Natural gas imports are expected to grow from 0.9 trillion cubic feet (Tcf) in 1976 to 1.5 Tcf in 1980, 2.1 Tcf in 1985 and 2.3 Tcf by 1988.[39]

IMPACT OF MEXICAN OIL ON U.S. ENERGY POLICY

The exporting of Mexican crude oil on a large scale will have some impact on U.S. energy policy. The development of large quantities of desirable crude oil a short distance from the largest refining area in the United States is certain to affect not only decisions concerning imports, but also domestic production. Of importance is the need for the United States to reconcile increased imports of Mexican oil with the existing policy of encouraging sales of Alaska North Slope (ANS) crude in the Gulf Coast refining market. This is a matter of great concern to North Slope producers who have no export option and need

[39] CRS Report Project Interdependence: U.S. and World of Energy Outlook Through 1990. November 1977, p. 4.

sales in the Gulf Coast to maintain production levels on the North Slope. The prospect of possible sales of Mexican oil on the U.S. West Coast may aggravate the existing surplus there.

U.S. Gulf Coast refineries process over one million b/d of foreign high sulfur crude oil. Both Mexico and the producers of Alaskan North Slope oil want to penetrate that import market. The degree to which these crude oils will be accepted will depend on several factors including price, quality, and security of supply. Table 15 shows the relative refining values of these oils based on the projected product slates of Gulf Coast refiners.

TABLE 15.—REFINING VALUES OF CRUDE OILS AT GULF COAST REFINERIES

Crude oil	Refining value (in 1977 dollars)	Value relative to Mexican Reforma (in 1977 dollars)	API gravity	Percent sulfur
Alaskan North Slope	$15.47	($0.38)	27.5	0.96
Arabian light "marker"	15.79	(.06)	34.5	1.80
Mexican Reforma	15.85	----------	33.3	1.51

The projected prices of Arabian light, Mexican Reforma, and Alaskan North Slope (ANS) crude oil delivered to U.S. Gulf Coast refineries are shown in Table 16. The prices of Mexican-Reforma and ANS crude oil are shown with and without discounting. Both of these crudes are already being discounted. Mexico discounts its oil to the extent required to gain market share. Arabian light crude oil is being displaced to the extent of availability of Mexican oil in that market. Mexican oil is also displacing ANS crude oil, causing ANS to be discounted on the Gulf Coast as well.

TABLE 16.—CRUDE OIL DELIVERED TO U.S. GULF COAST

[In billions of 1977 dollars]

Year	Arabian light [1]	Mexican Reforma [2]		Alaska North Slope [3]	
		Without discounting	With discounting	Without discounting	With discounting
1978	13.75	13.81	13.23–13.52	13.43	12.85–13.14
1980 [4]	13.19	13.25	12.88–13.07	12.87	12.50–12.69
1985	15.49	15.55	14.27–14.91	15.17	13.89–14.53
1988	16.35	16.41	15.03–15.72	16.03	14.65–15.34

[1] Based on the following assumptions: (a) Loop operational in 1980; (b) Worldscale for VLCC; (c) F.o.b. Ras Tanura as follows: 1977—12.70, 1980—12.32, 1985—13.55, 1990—14.75, in billions of 1977 dollars—from Pace report; (d) Import fee of $0.21 in 1978, $0.18 in 1980, $0.13 in 1985, $0.11 in 1990—in billions of 1977 dollars.

[2] Based on the following assumptions: (a) Monobuoy in gulf by 1979–80; (b) Loop operational in 1980; (c) Worldscale for VLCC; (d) Quality differential; (e) Until Loop is operational, tanker size is limited to less than 50 M dwt; (f) Discounting of Reforma crude equal to quality differential plus transportation differential or ⅓ of the same; (g) Import fee in billions of 1978 dollars—$0.21 in 1978, $0.18 in 1980, $0.13 in 1985, $0.11 in 1988—in billions of 1978 dollars.

[3] Based on the following assumptions: (a) PACTEX operational in 1981; (b) Loop operational in 1980; (c) Current tanker practice until Loop operational then VLCC's until PACTEX operational; (d) Mexican Reforma crude as marker crude.

[4] Reflects 1-time reduction in unit transportation costs because of access to VLCC's through completion of LOOP.

Note: Current price of Mexican Reforma crude, $13.57 per barrel U.S. gulf coast.

Source: Mario Cardullo, Impact of Mexican Crude Oil Exportation on U.S. Gulf Coast Refineries and Alaskan North Slope Crude Oil, Department of Energy, Aug. 31, 1978.

If the PACTEX Pipeline (a large-diameter line that would move 500,000 b/d of mostly North Slope crude oil from Long Beach, California to Midland, Texas) is built, it would provide an improved com-

petitive position to the producers of ANS crude because the transportation savings over transit costs of the Panama Canal route currently used. Because Standard Oil of Ohio (SOHIO), the largest ANS producer, has a sizable investment in PACTEX and is effectively prohibited by law from exporting ANS crude oil, it would likely discount its oil to whatever level is necessary to make its crude oil preferable to Mexican oil in the Gulf Coast refining market. Mexico has alternative markets and as a result could be expected to meet these discounts only to the point where they equal transportation costs to these alternate markets. Thus, Mexico will probably price its oil just low enough to back out Arabian light but not low enough to displace ANS crude on a large scale.

THE IMPACT OF MEXICAN GAS ON U.S. ENERGY POLICY

In order to evaluate its impact on U.S. energy policy, Mexican gas must be seen in the context of future supplemental gas supplies which will augment U.S. decreasing gas production in the lower 48 States in the 1980's. The major types of supplemental gas supplies are the following: (1) Canadian imports; (2) Synthetic natural gas (SNG); (3) Mexican imports; (4) Alaskan gas; and (5) Gas from coal. The United States will gear its demands for these supplementals on many factors.[40] Three important such factors will be the supply potential of each source, the price of each source, and how the price would be integrated into the existing U.S. regulatory structure.

The potential supply of supplemental gas during the period 1978 to 1988 is estimated by the Gas Supply Committee of the American Gas Association (AGA).[41] The estimates are given below.

TABLE 17.—POTENTIAL CONTRIBUTION FROM SUPPLEMENTAL SOURCES OF GAS

[Trillions of cubic feet]

Source	1977 actual	1980	1985	1988
Canadian imports	1.0	1.4	1.4	1.2
SNG [1]	.3	.5	.9	.9
LNG imports [2]	.01	.6	1.6	2.1
Mexican imports		.4	.7	[3].9(1.5)
Alaskan gas				
Southern [4]			.1	.2
North Slope [5]			.7	1.3
Coal gasification [6]			.2	.8

[1] Estimate for 1980 includes plants in operation. Estimates for 1985 and beyond includes plants which are approved, planned and suspended. All estimates assume year-round operation.
[2] Estimates for 1980 and 1985 are based on only announced projects.
[3] CRS estimate.
[4] Southern Alaska includes onshore and offshore production south of the Arctic Circle.
[5] Assumes a 2d major gas transportation system in operation by the early 1990's.
[6] High-Btu gas only. Assumes suitable financing assistance (such as loan guarantees) for 1st few projects.

Note that CRS believes the potential for Mexican exports is significantly higher (1.5 Tcf) than does the AGA (.9 Tcf).

Many projects involving supplemental gas sources are either in the planning or construction stages and, as a result, only estimates exist for just how much these sources would cost in 1985, when most

[40] See CRS Publication, Supplemental Natural Gas Sources: Factors and Policy Issues. June 1978: 25 pp.
[41] American Gas Association. "Forecasts of Supplemental Gas Supplies." Gas Supply Review, May 1978, Vol. 6. No. 8, pp. 10–11.

projects should be completed. The following table shows representative CRS believes to be reasonable estimates of supplemental gas source prices in 1985:

TABLE 18.—1985 SUPPLEMENTAL GAS PRICES [1]

[In 1985 dollars]

	Mexican gas [2]	Canadian gas [3]	SNG coal [4]	SNG oil [5]	Alaska gas [4]	LNG [6]
1985	$4.88	$3.56–$4.88	$7.32–$8.04	$5–$6.75	$5.81–$6.11	$5.15

[1] Foreign sources of natural gas, and LNG prices are for delivery to the U.S. border, and the price estimates for U.S. produced SNG coal and oil are mainly production costs. The Alaska gas price of $5.81 is a U.S. border price estimate, but $6.11 reflects the large capital investment needed for delivery to the main U.S. distribution points in Dwight, Ill., and Antioch, Calif.

[2] Reflects a 15 percent OPEC price increase in 1979 and thereafter assumes a 7 percent annual increase in No. 2 fuel oil price

[3] CRS estimate based on Canadian and U.S. gas pricing policy.

[4] Prices for SNG coal and Alaskan gas from DOE intervention before FERC, ANG coal gasification company proceeding. FERC docket Nos. CP75-278, et al. June 1, 1978, p. 5.

[5] Estimate assumes naphtha as the feedstock and is based upon conversation with Bill Norman, J. Makowski, Associates, Boston, Mass.

[6] Tenneco Atlantic Algerian project.

The PEMEX estimate is based on Mexican gas price being tied to the No. 2 fuel oil price in New York Harbor. Canadian export prices for natural gas, in general, are determined by the market prices of competitive energy commodities in which the gas would be sold. The 1977 price hike to $2.16 was primarily based on the cost of Arabian light crude imported into eastern Canada, but also reflected the $2.25 price ceiling for the last winter's emergency gas sales in the United States as well as the cost of LNG supplies scheduled for the United States.

The Natural Gas Policy Act of 1978. (P.L. 95–621) will be a contributing factor to any future Canadian price. Although there are some 29 categories of new gas each with a different price mechanism, it appears that $2.00 per mcf is a reasonable price to assume for the new gas committed to markets in 1979. Applying the price escalation formula based on the following: the GNP deflator +.2 percent +3.5 percent until April 20, 1981, changing to the GNP deflator +.2 percent +4.0 percent 1985, one can assume the wellhead price of U.S. new gas to approach $3.56/mcf in 1985 assuming 6 percent inflation. As a result, Canadian gas will most likely be no less than the U.S. new gas price and probably no more than the projected Mexican gas price.

The LNG estimate is based on the "old" cost of service pricing formula by the Department of Energy's Economic Regulatory Administration (ERA). Recently, however, there was a "new" pricing formula approved by ERA on the Indonesian LNG project.[42] The new pricing formula would allow annual increases from the base price of $1.25 per million Btu ($3.59 after shipping and regasification), linked half to the U.S. wholesale price index and half to Indonesian oil price hikes up to 15 percent a year (with carryovers permitted to future years). If the current inflation trend continues, Indonesian LNG most likely will be more expensive than $5.15 in 1985.

The immediate effect of high prices for LNG or for any of the other supplementals to the consumer can vary depending on the end-use pricing policy. There are two main end-user pricing alternatives. The

[42] The Energy Daily. October 5, 1978, p. 4.

first is "rolled-in" pricing where the price of supplemental gas would be averaged in with the prices of the cheaper existing gas supplies producing a higher gas price for all consumers in the system, but a lower price than the actual cost of the supplemental gas. The other is an "incremental" pricing structure, where the actual end-user of supplemental gas would pay the full delivery price of that gas, while the user of non-supplemental gas would continue to pay the lower price of existing gas. Those end-users consuming some of each would be charged a weighted price based on the percentage of supplemental gas used and existing gas used.

The Natural Gas Policy Act of 1978 (NGPA) mandates that the price at the wellhead and transportation costs of Alaska natural gas be "rolled-in." The other supplemental gas sources most likely will be priced incrementally, but the cost of gas to the user depends on priority of the user consuming the gas. As a general rule the NGPA requires that the lower priority user, such as the industrial user, pay the incremental price for gas while the higher priority users, residential and commercial users, would continue to pay the less expensive price for gas.

In sum, it appears that Mexican and Canadian gas are the least expensive supplemental source of gas available to the United States, but it may not appear that way to the consumer if all supplemental gas is not treated similarly in the regulatory scheme.

ENERGY AND FUTURE UNITED STATES-MEXICAN RELATIONS

The likelihood of the United States importing significant amounts of Mexican oil and natural gas could have a profound and lasting impact on the nature of future United States-Mexican relations. The issues will be much the same as they are currently, but the new phenomenon of vast Mexican oil reserves will cast the relationship in an entirely new context and will demand a relatively new and different approach. The problems of immigration and trade could become linked with United States interest in acquiring Mexican energy to satisfy its great demand, with the added prospect of enabling the United States to reduce its dependency on Middle East oil.

Mexico's energy potential has important implications for increased leverage in dealing with the United States; certain trade-offs are likely to be made in attempting to satisfy Mexican demands on specific issues in return for the oil and natural gas desired by the United States to fulfill its domestic and strategic needs. The availability of Mexican energy in large quantities could offset, to a large degree, overwhelming United States dominance and Mexican dependency, characteristics of the historical relationship.

The new energy dimension, in addition, will serve to magnify the stark reality of United States-Mexican relations: important domestic issues in both nations are seriously affected by each others policies. The demands for new approaches to these problems brought on by the energy prospects, however, could result in solutions benefitting both nations. The energy perspective also carries with it important implications surrounding renewed U.S. interest in having a friendly and politically and economically stable Mexico on its southern border.

PAST AND PRESENT FACTORS INFLUENCING RELATIONS

This "new" relationship has its roots in the past—roots which have influenced Mexican attitudes toward the United States and which, to a certain extent, will continue to influence Mexican policy. Beyond the estimates of Mexico's high energy potential and the attractive prospect of the United States being so close to the "black gold" are the political symbols of the past. Mexican slogans like "Poor Mexico, so far from God, so close to the United States," and depictions of the United States as the "Colossus of the North" are deeply ingrained in the Mexican psyche. The loss of one half of Mexican territory to the United States, U.S. military incursions, including the occupation of Mexico City, and significant manifestations of what the Mexicans consider U.S. economic imperialism are more than textbook historical events.

Additional features which have affected relations in the past and which will influence future relationships are those political and economic realities which have emerged as the legacy of the Mexican

Revolution. The principles of nationalism and strong central governmental institutions play important roles in Mexican domestic and foreign affairs.

Oil is a symbol of Mexican nationalism. The nationalization of oil asserted Mexican rights to its natural resources and defined the PEMEX role of social consciousness.

The centralized political system is also an important factor. The political character of the uniquely strong executive power in Mexico has swung in pendulum fashion from left to center, at times to center-right, and so have Mexico's domestic and foreign policies. The principle social and economic tenets of the Revolution, however, have continued through the various administrations. The political system is supported by the dominant party, the Institutional Revolutionary Party (PRI), which has given Mexico nearly 50 years of political stability. In recent years, however, PRI has shown signs of strain due, in part, to pressures from segments of Mexican society who feel they are not adequately represented in the system. Increasing evidence of unrest from the right as well as the left, and among the middle classes, has led the Lopez Portillo Administration to initiate steps toward political liberalization. A right-wing party and two left-wing parties, including the Communist Party, were legalized. The size of the Chamber of Deputies was increased from 250 to 400. One hundred of the seats were allocated on proportional basis to parties other than PRI, which was still guaranteed the majority of the seats. In addition, the Government passed an amnesty law freeing a number of persons, some of whom were regarded as political prisoners.

Population pressures have contributed to the astounding numbers of people seeking employment. President Lopez Portillo has pledged to consider the creation of jobs one of his administration's highest priorities and has called unemployment "the source of all injustices." [43] The lack of jobs has affected relations with the United States because of the related concerns of undocumented immigration.

THE NATURE OF THE UNITED STATES-MEXICAN RELATIONSHIP

Dependency is often used to describe the nature of U.S.-Mexican relations. Mexico sends over half of its exports and imports to the United States, and Mexico is the fourth largest trading partner of the United States. Tourism, Mexico's second largest industry, is generated primarily by visitors from the United States. Eighty-seven percent of Mexico's tourists come from this country. Since the early 1970's tourism has earned for Mexico about $2 billion annually. From 350,000 to 450,000 Mexicans are employed in the tourist industry.[44] Tourist dollars are a leading source of foreign exchange which helps offset Mexico's balance of payments deficit.

Since the inauguration of their governments, the Carter and Lopez Portillo administrations have conducted a continuing dialogue which seems to underline the importance with which they regard the bilateral relationship. Lopez Portillo was the first head of state to be officially received by President Carter in February 1977. To discuss basic issues and problems, Mexican Foreign Minister Santiago Roel has traveled to Washington about a dozen times. Vice-President Mondale in Jan-

[43] Washington Post, August 17, 1978.

[44] Ronfeldt, David and Cesar Sereseres, The Management of U.S.-Mexico Interdependence: Drift Toward Failure, RAND Corp., January 1978. (Prepared for the Department of State), p. 19.

uary 1978 and Secretary of State Vance in May 1978 have visited Mexico. President Carter is scheduled to visit Mexico on February 14–16, 1979.

Although some of the visits have been motivated by basic problems and issues that have negatively affected the U.S.-Mexican relationship, both the Carter and Lopez Portillo governments seem to have made an effort to reverse the poor relations resulting from the U.S. reaction to the policies of former President Luis Echeverria. Domestically, Lopez Portillo represents a move toward the political center from the policies of Echeverria. Internationally, the Mexican president has not continued the policies that thrust Mexico into leadership on Third World issues. Soon after taking office, President Lopez Portillo made it known that he wanted Mexico to be in closer dialogue with the United States. Evidence of this was the appointment of foreign policy officials considered pro-United States in orientation: Santiago Roel as Foreign Minister and Hugo Margain as Ambassador to Washington.[45] Foreign Minister Roel, in response to the visit by Secretary of State Cyrus Vance in May, noted that there was "a new awareness and new relationship of interdependence." In announcing the planned visit of President Carter to Mexico on February 14–16, the White House said that President Carter believed that the visit "will further strengthen the unique relationship between two nations that have always shared a common destiny." [46]

The uniqueness of the relationship suggests that the United States and Mexico have a "special relationship." Factors such as an undefended 2,000 mile border, a sharing of history, culture, and even people, and domestic problems that impact upon each other, add weight to the concept. Not everyone, however, accepts the idea of a "special relationship" between the two countries; some critics have regarded the concept as a paternalistic one which implies a Mexican dependency on the United States. A recent critic of the idea was Mexican Ambassador at Large Jorge Castaneda who said in a symposium in Washington that Mexicans no longer believe that "there exists or can exist a special relationship with the United States." Castaneda felt that adverse U.S. actions in the areas of trade and immigration would not be taken under a policy of "special relationship." [47] Perhaps behind Castaneda's negative attitude toward a special relationship is the realization that, although Presidents Carter and Lopez Portillo in the spring of 1977 agreed to coordinate policies on major issues and created a new consultative mechanism, the United States continued to act unilaterally in certain areas. On the positive side, during his May 1978 trip Secretary Vance attended a meeting of the joint consultative body, and new agreements were reached on extradition, tourism, and maritime limits.[48] Although some feel that the concept of "special relationship" is theoretically outmoded in this day of "global" perceptions of U.S. foreign policy, it remains a prominent concept to be considered in understanding United States-Mexican relations. The concept of "special relationship," in fact, could very well reach new prominence and importance under the new dimension of Mexican energy.

[45] New York Times, January 20, 1978.
[46] Washington Post, November 14, 1978.
[47] Washington Post, November 7, 1978.
[48] New York Times, May 5, 1978.

The mutual concerns of the two nations in the near future will continue to include those issues which seem to have been part of the relationship throughout the modern history of both nations. Problem areas such as Colorado River salinity, theft of archeological treasures, and treatment of prisoners in the jails of both nations will be considered along with other items that present themselves in a normal relationship between friendly neighbors. Higher on the agenda, however, will be the issues of trade and undocumented workers.

UNDOCUMENTED WORKERS

The number of undocumented workers living and working in the United States is estimated to be between two million and eight million. It is believed that over half of this number are Mexicans. The "illegal aliens" cross over the border primarily to seek employment and to escape poverty. They frequently take menial jobs not wanted by U.S. workers. They become susceptible to various forms of exploitation because of their fear of being reported to the Immigration and Naturalization Service (INS) for deportation. Many in the United States, including those in the labor movement, see the undocumented worker as a threat to jobs in an already insecure labor market and as having an adverse effect on wages and working conditions.

Migration provides Mexico with a "safety valve" for its tremendous population and economic pressures. In addition, the undocumented workers in the United States take back or send back to Mexico about $3 billion in U.S. dollars, i.e., more in foreign exchange than is earned from tourism, Mexico's second largest industry.[49]

In an attempt to stop the flow of illegal aliens, President Carter in August 1977 proposed to the Congress a new immigration policy which would: (1) make the hiring of undocumented aliens unlawful; (2) grant an amnesty to those undocumented workers who have resided in the United States continuously from before January 1, 1970 to the present and who apply with the INS for permanent resident alien status; (3) create a new immigration category of temporary resident alien for undocumented aliens who have resided in the United States continuously prior to January 1, 1977; and (4) double the border patrol, and promote continued cooperation with the governments involved.[50]

Thus far, the Mexican Government has refrained from official adverse criticism of the Carter policy. However, there was significant reaction, especially over the total absence of consultation, a mechanism the Mexicans thought had been created earlier with President Carter. Mexico was informed of the proposals only a few days before they were announced and was not given any opportunity to respond to them. One of President Lopez Portillo's advisers on emigration, Dr. Jorge Bustamante, was quoted in the New York Times as saying:

> The measures constitute an unfriendly gesture to Mexico because they imply a total lack of sensitivity of the economic situation of Mexico today. These are unilateral measures. The so-called mechanism of consultation between the two governments was nothing more than a mechanism of information. Mexico was simply told what was going to happen.[51]

[49] Fagen, Richard R., The Realities of U.S.-Mexican Relations. Foreign Affairs, Vol. 55, July 1977, p. 689.
[50] For an analysis of the immigration policy and the problem of illegal immigration see the Issues Briefs, and other works by Joyce Vialet, Specialist in Social Legislation, CRS.
[51] Shroeder, Richard, Mexican-U.S. Relations. Editorial Research Reports September 23, 1977.

In a recent move on the illegal immigration issue, the United States in October 1978, began the construction of 16 miles of fence along the border at El Paso, Texas, across from Juarez, and at San Isidro, California, across from Tijuana, the two busiest crossing points. Politicians on both sides of the border, including President Lopez Portillo, voiced criticism of the "Tortilla Curtain." According to a report,[52] the project has been "put on hold" and is being "re-evaluated" by the Carter Administration.

To deal partially with the problem, Mexico created "free-trade zones" near the border and the United States encouraged industry to locate near the border. Merchandise and equipment shipped to these zones are free of custom duties, as long as they do not enter the rest of Mexico. The zones are part of the "maquiladoras" program, whose objective is to match American technology with Mexican labor. American industrialists put up plants in Mexico on or near the border, materials go into the factory free of Mexican import duties, and the finished products are returned into the United States free of American tariffs. There are some 80,000 Mexicans working in such factories.[53] The Mexican Government is contemplating further incentives to lure even more U.S. industry to the border area. One such incentive would allow border industries to supply the entire Mexican market.

TRADE

The pattern of U.S.-Mexican trade is changing. The United States has had a large positive trade balance with Mexico, but in recent years it has become smaller. Due to increasing imports of petroleum products from Mexico, 1978 may be the year in which the U.S. trade balance with Mexico becomes negative. This does not necessarily mean that U.S. exports will decline. In order to continue its growth, Mexico will have to import considerable quantities of production and capital goods plus increasing amounts of foodstuffs for its rapidly growing population.

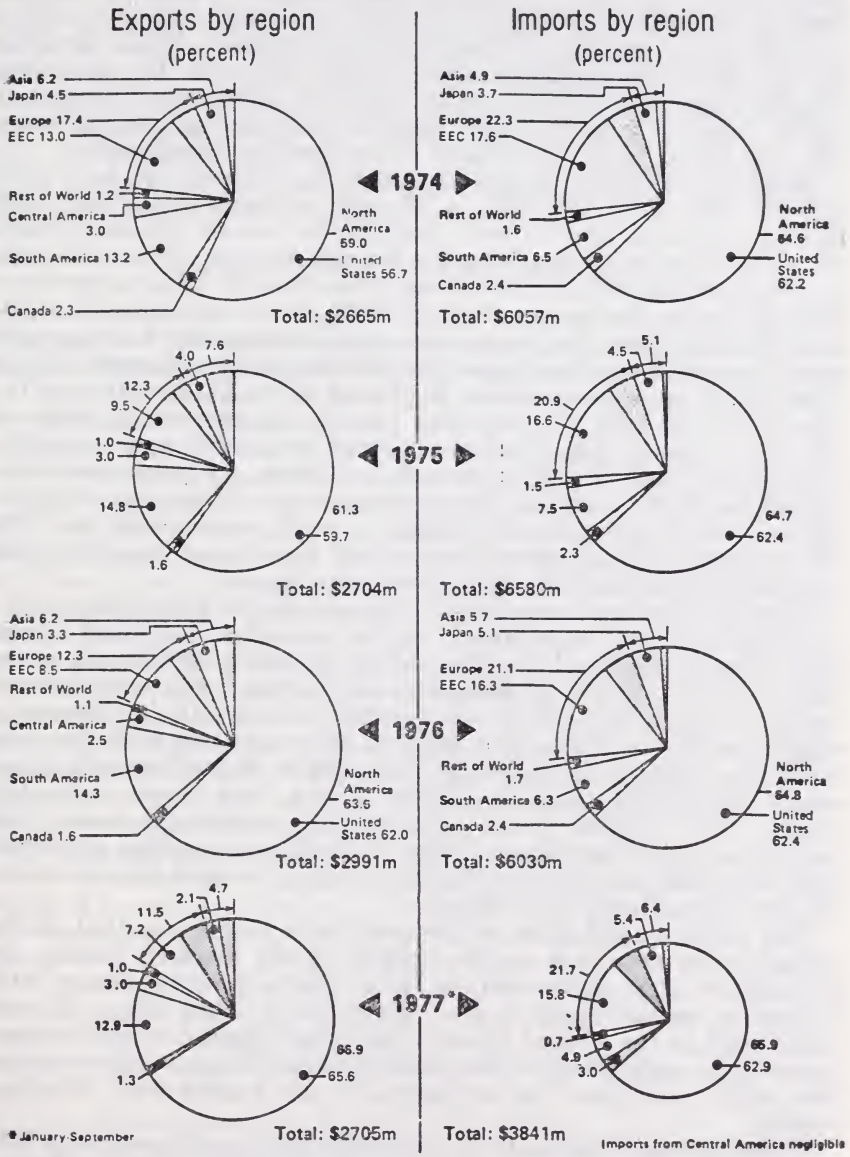
Several factors are combining to increase the Mexican demand for manufactured goods. PEMEX has a $16 billion investment plan for 1977–82. The Federal Electrical Commission plans to double power generation within eight years. Mexico needs to expand agricultural production, which will in turn increase the demand for agricultural machinery of all types. Finally, Mexico's plans to further develop its capital goods industry will require imports of sophisticated machinery. In the meantime, Mexico will continue to import growing quantities of basic foodstuffs until the output of its agricultural sector increases at a higher rate.

The United States has traditionally enjoyed the role of primary supplier and buyer in Mexican trade (see chart 4), and this role has increased in the last few years. From 1974 to 1977, Mexican imports from the United States rose from 62 to 63 percent of its total, and Mexican exports to the United States rose from 58 to 66 percent of Mexico's total. Mexico's proximity permits fast delivery, lower transportation costs, and easily accessible servicing and technical assistance for both countries.

[52] Washington Star, November 7, 1978.
[53] Gordon, *op. cit.*, p. 34.

Chart 4

The pattern of Mexico's trade



* January-September

Imports from Central America negligible

Source: *Euromoney*, April 1978, p. 23.

The Mexican market for U.S. goods, however, is very different than the U.S. market for Mexican goods, especially because of the regulatory framework in which each market operates. Import permits are required from the Ministry of Commerce for most items imported into Mexico. The license procedure was adopted originally to try to control Mexico's traditionally unfavorable balance of trade as well as to promote and protect local industrial development. While the trade and industrial development situation has improved, the procedure remains cumbersome because of the elaborate bureaucratic process. It usually takes six months to get a permit, a prohibitive time constraint for some products, and sometimes it is altogether unobtainable.

Mexico is trying to change its import licensing system to a tariff system. Since February 1977, a Mexican commission on tariffs and foreign trade controls has been studying its import licensing system with the objective of dissolving the bureaucratically cumbersome permit requirement while still providing protection for Mexican products through higher duties. As of April 1978, 2,322 tariff classifications were removed from the licensing system bringing the total to 3,552 goods exempt from the import permit (license) requirement. While these classifications account for 48 percent of the 7,339 numbers in the Mexican tariff code, they amount to only ten percent by value of Mexico's imports. The products covered are largely raw materials, agricultural goods and luxury consumer items. As items are decontrolled, tariffs are raised to provide protection for local manufacturers. Mexico's tariff system is supposed to be totally restructured by 1982. Although officials talk about the eventual lowering of the new tariffs, no schedule of reduction has yet been announced.

Most of Mexican imports to the United States are subject to the regulations of the "most favored nation status" of the Tariff Agreements Act of 1934 and the Generalized System of Preference of the Trade Act of 1974. Any foreign country what holds most favored nation status benefits from any present or future trade concessions which the United States may grant to other countries with the same status. For example, if the United States lowers its tariff on a Canadian commodity coming into the United States, that same commodity coming from Mexico would automatically receive the same tariff reduction. The Generalized System of Preference enables countries, most of which are underdeveloped countries, to send exports to the United States free of U.S. duties.

One major qualification to the preference program is that, if the exporting country is a major supplier of the product, having the potential to harm significantly a United States industry, then a tariff is imposed on the import to the United States. Even though Mexico is included in the United States Generalized System of Preferences, many of its agricultural exports to the United States, such as cucumbers, okra, cauliflower and tomatoes, do not receive total duty-free status.

United States-Mexican trade negotiations are usually ongoing. The latest trade agreement came in December 1977, when the United States and Mexico signed a bilateral trade agreement under the auspices of the Tropical Products segment of the Multinational Trade Negotiations going on in Geneva. In the agreement, the U.S. concessions included $63 million worth of tariff reductions on imports of

Mexican products, and Mexico's concessions included $36 million worth of tariff reductions on imports of U.S. products.[54]

As a rule, however, trade agreements between the United States and Mexico are hard to achieve. Both countries have erected protective barriers for their domestic industries, and to reduce those barriers might result in creation of jobs in one country and the loss of jobs in the other country within any one industry. Without tariffs, Detroit could probably undersell Mexico in the automobile industry, but for some agricultural products such as tomatoes and strawberries, Mexico could probably undersell the United States at certain times of the year. In the short term at least, opening the automobile market would mean more jobs for the United States, and more unemployment for Mexico and vice-versa in agriculture.

ISSUES DIRECTLY RELATED TO ENERGY

Those specific issues directly related to energy could become the cornerstone of the "new" relationship, setting the tone and environment for the rest of the agenda. In the next months and beyond, both the Lopez Portillo and Carter administrations will be searching for the appropriate policies, weighing their nation's political, economic, and international interests as well as the implications of their decisions.

A preview to the sensitivities involved in issues directly related to energy, but hopefully not to the ultimate policies of both countries, was given in late 1977 by the conflict over the purchase price of Mexican natural gas to the United States. The conflict ended with the Carter Administration refusing to approve the natural gas deal and Mexico suspending the negotiations. Mexico has since stated that it no longer intends to export its gas reserves and is going to create a nationwide distribution network to consume the gas domestically.

It is likely that the Mexican Government's decisions on future energy policy will be related, in large part, to Mexico's goal to better balance its relationship with the United States. Currently, the discussion in Mexico is over whether vigorous energy dealings with the United States will help to achieve this goal or, to the contrary, whether it will serve to reinforce the dependency.[55]

One element in the discussion, and perhaps the most important consideration for the Mexican Government, is the volume or percentage of production Mexico should export to the United States. The increased revenues that would most likely come from such a sales arrangement could be offset by the greater influence of the United States on the Mexican economy and even the future political system. Mexico's nationalism and traditional perceptions of the United States would certainly be called into play. It is being argued in Mexico, especially from those on the political left, that Mexico should not supply the United States with vast amounts of energy. According to this view, Mexico should allow most of the energy resource to remain in the ground so it can grow in value. Mexico would produce enough to develop its economy, with modest exports to earn foreign currency. The statement attributed to a Mexican Cabinet member that "Mexico

[54] Ronfeldt, David F. and Sereseres. *op. cit.*, p. 13.
[55] Ojeda, Mario. Mexico: The Debate over the New Oil Resources. Paper prepared for the Rockefeller Foundation's U.S.-Mexico Relations Workshop on Petroleum, October 30–31, 1978.

will not commit itself to supplying the United States with petroleum," is an indication of the political debate that lies ahead.

The Mexican drive to achieve greater independence from the United States seems to be underway through the diversification of its oil exports. The Mexicans are seeking new markets in Bulgaria, Greece, Turkey, Yugoslavia and Rumania. In October 1978, Mexico significantly broadened its overseas market by signing export contracts with Japan and France. PEMEX recently confirmed a deal with Japan's Mitsubishi Corporation, and it has been said that by the 1980's Mexico could be exporting as much as 220,000 b/d to Japan. It is also possible that by 1980 Mexico could be exporting at least 50,000 b/d to France.[56]

The Japanese are not disguising their interest in securing quantities of Mexican oil and have engaged the Mexicans in discussions on large-scale economic cooperation involving Mexican oil and Japanese technological assistance for the modernization of Mexico's ports and the development of its fishing industry.[57]

[56] The Wall Street Journal, October 17, 1978.
[57] Journal of Commerce, October 16, 1978.

APPENDIX

THE GEOLOGY OF MEXICO'S OIL AND GAS RESOURCES

The first oil well in Mexico was drilled in 1869 near the Furbero seeps in Vera Cruz. Commercial oil production, however, was not established until 1904. In that year the La Paz exploration well was drilled in San Louis Potosi. Subsequent oil development was very rapid with many large accumulations discovered in the next few years. Most of the new fields were in southern Mexico along a geological trend named the Golden Lane. In 1921, maximum production reached a peak of 193 million barrels, or about 530,000 barrels a day, and represented 25 percent of world production.[1] A sharp decline followed, due to the rapid exhaustion of the Golden Lane reservoirs which are composed of highly permeable limestones. In 1938, total annual output had fallen to only 39 million barrels or about 107,000 barrels per day.[2]

In the early 1970's Mexico had to become an importer of oil to meet its domestic consumption requirements. However, the discovery of new oil reserves near Tampico and Tuxpan during 1968 to 1970, and especially in the Chiapas-Tabasco-Campeche area after 1972, made Mexico again self-sufficient in oil by 1974. In the fall of 1974, Mexico resumed exporting. The amount was 35,000 barrels of crude oil per day. Average daily exports increased to 0.250 million barrels in early 1978 and are now about 0.440 million barrels per day.[3]

Mexico's proven oil, gas equivalent, and gas liquids reserves have been estimated at 20 billion barrels as of September 1978. This is up from 14 billion barrels at the end of 1977 and from 7 billion barrels at the end of 1976. Probable reserves have been set by PEMEX at 37 billion barrels and possible resources at 200 billion barrels.* Production has increased from under a million barrels per day in 1977 to a current 1.4 million barrels per day. Gas production is about 2.5 billion cubic feet per day. The areas of oil and gas interest in Mexico are discussed in the following sections.

Areas of Hydrocarbon Accumulations

NORTHEASTERN AREA FIELDS (PIEDRAS NEGRAS—MONCLOVA PROVINCE)

The Burgos basin in northeastern Mexico accounts for relatively little oil production, but is an important producer of natural gas. The area is geologically a part of the Rio Grande embayment of the Gulf Coast geosyncline. Structural hydrocarbon traps consist mainly

[1] Tiratsoo, E. N. Oilfields of the World. Gulf Publishing Company, Houston, Texas. Second Edition, 1976, p. 290.
[2] Ibid.
[3] Kennedy, Tom, PEMEX Expects Mexican Crude Potential of 100 Billion Barrels. The Oil Daily, June 30, 1978.
* Note: On January 2, 1979, oil and gas equivalent reserves we e revised upward. The new figures are: proven—40.1 billion barrels, probable—44.6 billion barrels, and possible—200 billion barrels.

of gentle folds with northwest-southeast axis. The main gas producing formations are the Eocene and Oligocene sands.[4]

Two important gas fields in the area are Reynosa, on the Texas border, and Brazil, to the southeast. Trevino, a few miles east of Reynosa, is an oil field. Other oil producing fields in the Northeastern Area include those listed in the following table adapted from the Oil and Gas Journal of December 26, 1977.

TABLE 1.—OTHER OIL PRODUCING FIELDS IN THE NORTHEAST AREA

Field (discovery date) and depth	Wells	Average production (barrels per day)	Cumulative production (barrels)	API gravity
Fco. Cano (1949) 5,780 ft	4	208	4, 722, 677	48
Monterrey (1950) 6,950 ft	20	698	10, 882, 939	47
Tigrillo (1971) 9,844 ft	6	101	1, 063, 041	55

Several new gas fields have been discovered in recent years, including Pinta, Rene, and Campo Llanura. They are all in anticlinal structure with Oligocene or Eocene sandstone reservoirs.[5]

For the first time commercial gas fields were discovered outside of the Gulf coastal plain. PEMEX has located and begun to develop gas reserves in the Sabinas basin of Coahuila and Nuevo Leon near the U.S. border. Gas is being produced from Jurassic rocks at the Lampazos, Monclova, Travertino, and Bueno Suerte fields. The discoveries to date have been on anticlines, but there may also be stratigraphic prospects. About 15 percent of Mexico's gas reserves are located in the Sabinas Gulf Field, southwest of Laredo, Texas. It is estimated that the field has reserves of six trillion cubic feet of gas. Eleven wells are producing 150 million cubic feet of gas per day and some of the wells have a reported open flow potential of 100 million cubic feet of gas per day. The field is reported to be 20 miles long and five miles wide and to produce from a zone 1,000 feet thick.[6]

TAMPICO-NAUTLA, VERACRUZ PROVINCE

The Tampico-Nautla Embayment is, in part, an extension of the Gulf of Mexico Tertiary geosyncline. The western part of the province is comprised of a separate Paleocene basin paralleling the Sierra Madre Mountains.

The northern fields of this province occur on a south-plunging prolongation of the Sierra Tamaulipas Mountain anticline. The principal oil reservoirs are the Cretaceous Tamaulipas limestone, the Agua Nueva limestone, and the base of the San Felipe limestone. In recent years there has also been production from an Upper Jurassic oolite.[7]

The Tamaulipas and Agua Nueva limestones are very dense and represent deeper water facies of the main reservoir beds of the southern Mexican fields. Oil production from these dense rocks depends largely upon the existence of secondary porosity and permeability caused by fissuring, solution, or jointing. Thus, wells drilled into this formation

[4] Tiratsoo, E. N., op. cit. p. 291.
[5] Ibid.
[6] Mexico Sets 150 Percent Export Increase. The Oil Daily, October 4, 1978.
[7] Tiratsoo, E. N. op. cit.

vary greatly in productivity even over short distances due to varying local reservoir conditions.[8] The source rocks for the oil are considered to be the Kimmeridge section of the underlying Jurassic rocks, the black shales in the Tamaulipas limestone, and/or the basal limestones and black shales of the Agua Nueva formation.[9]

The first field found in this area, which contains many oil seeps, was at Ebano in 1904. Since that time a number of fields have been discovered, lying in an irregular arc to the west of Tampico. The most important of these fields are Ebano, Panuco, Topila, Cacalilao, Corcorado, Chijol, Quebracho, and Altamira. The oil is heavy, with a high sulfur content.

An important discovery was made offshore in 1968. The Arenque Sur field, located east of Tampico, has a limestone reservoir of Late Jurassic age and is located on a large north-south trending structure. It is currently producing about 21,000 barrels per day.

The Tuxpan fields were discovered to the northwest and west of Tuxpan, along a narrow, arcuate, anticlinal ridge which extends 51 miles, from Dos Bocas in the northeast to San Isidro in the South. Asphaltic seeps are common in this region and are often associated with igneous intrusions. The arcuate anticlinal ridge, known as the Golden Lane, contained the following important oil fields: Dos Bocas, San Geronimo, Juan Casiano, Amatlan, Zacamixtle, Toteco, Cerro Azul. Potrero del Llano, Cerro Viejo, Tierra Blanca, Chapapote, Nunez, Alamo, Jardin, Paso Real, and San Isidro. These fields occurred in structural highs along a large undulating fold, separated from each other by faults or local saddles. The limestone formation which formed the principal oil reservoir was a barrier reef in Lower Cretaceous time. At present it consists of about 8,000 feet of massively bedded limestone which outcrops at the surface in a nearby mountain range. Consequently, the oil fields have a strong natural water drive. Also, the limestone has probably been the source rock for the oil it contains. Primary porosity is principally due to hollow fossil casts and shell breccia. Fracturing, faulting, and solution cavities have added greatly to the natural porosity and permeability of the reservoir.

Development of the Golden Lane oil fields began in 1910. The fields were the most important in the country until 1933, since every well drilled into the reservoir was a large oil producer.[10] Some wells produced tremendous flows of oil. The initial output of Cerro Azul No. 4 was 260,000 barrels per day and the first Dos Bocas well flowed out of control for two months at an estimated rate of 200,000 barrels per day.[11]

However, the wells also tended to produce salt water suddenly when they were reached by the oil-water contact. Within this productive belt, more than 1,000 wells have been drilled of which more than half were oil producers. The district has produced about 1.25 billion barrels of oil. Production was rapid and increased steadily to a peak in 1921. However, the great reservoir permeability that permitted rapid exploitation also led to an extraordinary rapid production decline and in 1919 salt water began to invade the fields.[12]

[8] Ibid.
[9] Ibid.
[10] Ibid, p. 293.
[11] Ibid.
[12] Viniegra, Francisco O. and Carlos Castillo-Tejero. Golden Lane Fields, Veracruz, Mexico. Geology of Giant Petroleum Fields. The American Association of Petroleum Geologists, Tulsa, Oklahoma, November 1970, p. 311.

The output from the Golden Lane fields has declined, but other similar accumulations have been discovered on roughly parallel limestone structures both to the west and, more recently, to the east in the Gulf of Mexico. Thus, the Tres Hermanos field, northwest of Tuxpan, is now a large producer. Morallilo and Solis are other important onshore accumulations. Offshore, there have been several discoveries along what is now called the Marine Golden Lane. These fields are: Arrecife Medio, Isla de Lobos, Tiburon, Esturion, Bagre, and Atun. The Atun field appears to be the largest.[13]

The Golden Lane structure continues in an arc extending to the southeast between Tuxpan and Nautla. The Poza Rica field was discovered on this structural trend on a locally plunging anticline. The reservoir is a porous limestone of Lower Cretaceous age. Discovered in 1928, the field currently produces at a rate of about 47,200 barrels per day. Other similar accumulations on the same structural trend include: Soledad, Miquetla, Jiliapa, Remolino, and San Andres-Hallazgo.

A parallel trend, nearer to the coast, has produced a number of smaller discoveries, and a continuation of the Marine Golden Lane has also been found to contain oil accumulations at Morsa and Escualo.[14]

The Veracruz basin lies to the southwest of the Tampico-Nautla embayment, but differs from it stratigraphically because of facies changes in the Cretaceous rocks. The oil reservoirs are Cretaceous limestones, and there is gas output from Oligocene sandstones.

The first oil was discovered in the Angostura field in 1953; other accumulations include Cocuite, San Pablo, Ricon Pacheco, and Mirador.

During 1976, 15 exploratory wells were drilled in the Poza Rica-Veracruz area. Production was obtained from five of these wells. Two wells were notable, both with initial production of several hundred barrels of oil per day from Cretaceous rock. Eight significant discoveries were reported in the region in 1977.[15]

TABLE 2.—PARTIAL LIST OF THE OIL PRODUCING FIELDS IN THE TAMPICO-NAUTLA, VERACRUZ PROVINCE

Name of field, discovery date	Depth (feet)	Number of wells: Flow	Pump	Gas lift	Shut in	Production in barrels: Daily average, 1st 6 mo 1977	Total cumulative July 1, 1977	API gravity
Northern fields:								
Arenque, 1970	11,362	21				20,858	35,272,848	26
Barcodon, 1959	4,370	6	2			283	8,795,709	17
Constituciones, 1956	6,300	50		34		6,176	49,219,910	17
Ebano-Panuco, 1901	1,450	169	48	226		6,328	937,822,168	12
Tamaulipas, 1956	4,200	47		39		6,827	47,403,314	18
Cabo, Nuevo 1967	5,753	1				447	10,887,361	16
Isla de Lobos, 1963	6,875	3				1,233	19,103,202	40
Marsopa, 1974	10,198	8				5,114	5,952,994	36
Naranjos-C. Azul	1,800	200				8,473	1,186,023,901	20
Soledad Norte, 1973	5,222	36				1,276	1,672,888	
Tiburon, 1965	7,314	5				365	5,940,635	20
Tres Hnos, 1959	6,960	19				3,787	93,808,154	21

[13] Tiratsoo, E. N., op. cit., p. 293.

[14] Ibid.

[15] Amato, F. L. Petroleum Developments in South America, Central America, Mexico, and Caribbean Area in 1976. The American Association of Petroleum Geologists Bulletin, October 1977, p. 1588, and Amato, F. L. Petroleum Development in South America, Central America, Mexico, and Caribbean Area in 1977. The American Association of Petroleum Geologists Bulletin, October 1978, p. 2054–2056.

TABLE 2.—PARTIAL LIST OF THE OIL PRODUCING FIELDS IN THE TAMPICO-NAUTLA, VERACRUZ PROVINCE—Continued

Name of field, discovery date	Depth (feet)	Number of wells			Production in barrels		
		Flow	Pump	Gas lift	Shut in	Daily average, 1st 6 mo 1977	Total cumulative July 1, 1977	API gravity
Central fields:								
Atun, 1966	9,040	4				1,076	30,081,780	37
Bagre, 1973	10,919	10				11,945	17,024,237	
M.A. Camacho, 1952	5,340			9		377	2,896,564	35
C. del Carbon, 1960	9,396	1		32		629	3,542,748	
Escualo, 1969	9,840	1				239	1,164,575	36
Hallazgo, 1955	10,170			56		4,749	61,985,421	25
Jiliapa, 1958	7,390			35		1,497	24,793,249	34
Miquetla, 1959	6,480	23		34		2,258	18,877,523	35
Morsa, 1971	10,434	1				459	10,009,252	37
Nvo. Progreso, 1955	7,185			14		352	6,968,150	31
Papantla, 1962	9,086			12		258	3,320,598	
Poza Rica, 1930	7,090	67	15	299		47,187	1,115,877,434	35
Remolino, 1962	10,745			54		1,887	17,580,493	
Riachuelo, 1972	10,798	3				484	1,482,817	
San Andres, 1956	10,410	5		160		29,223	274,881,127	29
Acuatempa, 1955	4,085	13				1,541	24,047,292	21
Alamo, Jardin, P. Ral, 1957		22				472	22,416,403	
Copal, 1957	4,610	10	6			333	1,698,155	15
El Muro, 1966	3,966	7				4,730	14,630,490	17
E. Ordonez, 1952	5,220	13				1,912	53,873,907	21
Mesa Cerrada, 1956	4,085	6				440	10,839,934	22
Ocotepec, 1953	3,737	13				572	18,220,142	20
Santa Agueda, 1953	4,789	30				3,824	96,653,316	16
Angostura, 1953	4,405	8				346	21,954,836	15
Matapionche, 1974	11,129	3				623	1,762,986	37
Southern fields:								
Agata, 1956	3,830	3		10		673	10,175,540	34
Cuichapa, 1935	2,200	30	4	76		18,794	93,587,985	30
El Burro, 1931	2,200		11	6		1,050	18,699,125	26
El Plan, 1931	1,700	1	23	56		3,460	144,193,017	30
Ixhuatlan Ote, 1965	3,952	11	2	10		1,667	5,665,529	22
Los Soldados, 1953	4,492	8		14		1,378	20,354,446	32
Mecoacan, 1948	1,397	5	147	69		5,120	10,899,117	26
Santa Rosa, 1959	1,034		11			170	4,839,155	36
Tacuilolapa, 1955	2,925	1		1		277	2,699,649	36
Tonala, 1928	1,770	3	23	12		1,384	73,564,425	28
Lacamango, 1972	1,900	24				3,736	1,808,167	32
Concepcion, 1973	1,680	8				1,799	688,906	34

Source: Oil and Gas Journal, Dec. 26, 1977.

CHIAPAS-TABASCO (REFORMA) PROVINCE AND CAMPACHE CONTINENTAL SHELF

In the Tabasco area, the Macuspana Basin contains oil reservoirs in Miocene sandstones in local anticlines. The Jose Colomo field, discovered in 1951, contained several trillion cubic feet of gas.

The most important petroleum deposits in the Province and in Mexico, however, are located in the Reforma area of Chiapas and Tabasco, discovered in 1972. By 1975 five oil fields were being developed (Cactus, Sitio Grande, Cunduacan, Sabancuy, and Samaria) with a combined output of 310,000 barrels per day, nearly half of the national total. The fields are productive from the Cretaceous interval, a sequence of dolomites and calcarenites as much as 1,500 feet thick.[16] At the end of 1975, production rates per well were reported to be averaging over 4,200 barrels per day, contrasting with a national average of 110 barrels per day per well. The Chiapas-Tabasco wells were exhibiting gas/oil ratios, averaging about 1,770:1. Development was speeded as 31 drilling rigs were moved into the area. Also, construction

[16] Franco, Alvaro. Recent Discoveries Vault Mexico in New Position. The Oil and Gas Journal, October 21, 1974, p. 74.

was started on a complex of plants to treat and desulfurize the associated gas which was being flared.[17]

Two more Reforma fields were discovered early in 1975; Nispero, northeast of Cactus, and Iride, northeast of Samaria, bringing the total number of fields to seven. Waterflooding was planned for the Sitio Grande field with injection rates of 300,000 barrels per day. Repressuring of Reforma fields during their early productive life is considered necessary by PEMEX as they are undersaturated and have a tendency to lose pressure quickly.[18] Field wells completed in Cunduacan, the northernmost field, were reported to have flowed as much as 18,000 barrels per day of oil.[19]

By 1975 the geology of the area had been described by PEMEX. The Reforma structures are complex, domed features, dislocated by a large number of normal faults and, in some cases, transcurrent faults. The reservoirs are Middle Cretaceous in age and consist of detrital, calcareous rocks. Eocene, Oligocene, and Miocene clays and sands uncomformably overlay the Cretaceous rocks. Thicknesses of the oil-saturated column varies among the five earliest discovered fields in the trend. Cunduacan has about 3,000 feet of oil saturated rock above the formation water; Cactus has about 2,600 feet; Samaria 2,300 feet; and Sabancuy and Sitio Grande about 1,500 feet each.[20] Permeability of the reservoir rocks is a product of their reef and detrital origin, which preserves a large part of original porosity. In addition, subaqueous solution by meteoric waters, dolomitization, and fracturing generated in part by vertical forces of Jurassic salt contribute to permeability.

Genesis of the Yucatan platform coincided with that of the Golden Lane atoll on the Vera Cruz coast. The two platforms are believed to have had slow, but extended growth with giant escarpments of reef origin. Clastic calcareous sediments, ranging from 300 to 1,600 feet, were deposited through submersions over prolonged periods of time, which formed a karst topography, including solution caverns.

Thus, the size and productivity of the Reforma area is thought to be governed by the distance along the Yucatan platform that the carbonate clastics were generated and the extent of the Upper Jurassic marine deposits, which are considered to be the source beds for the oil and gas.[21] The extent of the Jurassic salt will also be a factor as associated fracturing is believed to have increased permeability by almost 50 percent.[22]

In 1976, new Chiapas fields included Rio Nuevo, Agave, and Mundo Nuevo with additional wildcat wells drilling in the Cretaceous reservoir below 13,000 feet northwest of the Agave discovery. Tabasco's new fields were Tres Pueblos, Crisol, and Tierra Colorado (which was a Jurassic strike). In every case the discovery wells encountered sizable reservoirs with potentially productive, calcareous, oil saturated zones from 650 to 2,300 feet thick.[23] The potential of the Jurassic formations was tested and Jurassic oil production was realized in several fields.

[17] Franco, Alvaro, Mexico Sees Imports End By Year-End. The Oil and Gas Journal, April 29, 1974, p. 24.
[18] Franco, Alvaro. Mexico's Crude-Exporting Role May Be Short-Lived. The Oil and Gas Journal, May 26, 1975, p. 26.
[19] Ibid.
[20] Ibid., p. 27.
[21] Ibid.
[22] Ibid.
[23] Franco, Alvaro, New Reforma Finds Push Mexico to New Oil Heights. The Oil and Gas Journal, May 17, 1976, p. 72.

The main limitation to additional Jurassic tests was the lack of heavy rigs which could drill below 20,000 feet. Drilling also had confirmed two structural trends paralleling the original Reforma fields.

By the end of April 1976, 80 wells in Reforma fields were producing 442,000 barrels of crude oil per day, for an average of 5,524 barrels per day per well. Combined crude oil and gas liquids production was 950,000 barrels per day.[24]

About half of the production came from 23 wells in the Samaria field (an average of 9,700 barrels per day per well). Cunduacan's contribution of 70,000 barrels per day from six wells indicates a per well average of 11,560 barrels per day. Wellhead pressures, averaging 1,700–1,845 pounds per square inch, had continued practically unchanged after two to three years of sustained production.[25] Sitio Grande, however, had experienced formation water production of up to ten percent in some wells. Thus, these wells were shut in until a planned waterflood program could get underway.

Early in 1977 four discoveries (Artesa, Giraldas, Copano, and Sunuapa) extended the producing trend southward by about 16 miles. The fifth find was made on the Oxiacaque structure, east of Cunduacan. In each of the discoveries PEMEX reported that the average thickness of the oil reservoir exceeded 1,300 feet. Production capacities were reported similar to wells producing about 5,500 barrels per day.[26] The new discoveries were reported to maintain the wildcat success ratio in Chiapas-Tabasco at about 80 percent.

Additionally, there were three successful wells offshore. These discoveries were at Chac, Akal, and Bakab, in the Sound of Campeche, about 43 miles northeast of the northernmost onshore field.

The discoveries to this date confirmed the presence of two new producing trends east and west of the initally discovered structures. New geological evidence seems to point to the existence of a giant prospective area extending north to the Gulf of Mexico, south to the foothills of the Chiapas Range, east to the Yucatan Peninsula, and west to the State of Veracruz. Cretaceous discoveries made by PEMEX at Copite and Matapioche in Veracruz, and by Shenandoah in Guatemala, could be correlated with Reforma and thus support this assumption.

The Reforma fields cover a small area within the large Yucatan platform that existed during Mesozoic time. PEMEX believed that the entire region is an exceptionally attractive anticlinorium, and that hydrocarbon production could conceivably cover a much greater area than the one proved so far.[27]

However, toward the end of 1977, PEMEX reported that seismic data from onshore and offshore surveys had indicated that the offshore discoveries in the Bay of Campeche were not a marine prolongation of the Reforma trend, but were instead part of a large new structural trend believed to extend from south of Ciudad PEMEX to north of Ciudad del Carmen Island (about 214 miles). This trend appears to have characteristics similar to those at Reforma, but with far larger potential in calcareous Tertiary formations, found productive for

[24] Ibid., p. 73.
[25] Ibid.
[26] PEMEX Has New Chiapas-Tabasco Finds. The Oil and Gas Journal, May 2, 1977, p. 120.
[27] Franco, Alvaro. Southeast Mexico Ranked Hottest Action Area in Latin America. The Oil and Gas Journal, February 21, 1977, p. 103.

the first time in southeastern Mexico. The three offshore discoveries were found to be productive in Paleocene limestones.[28] Far to the south, PEMEX drilled its Zapatero No. 1 wildcat about 28 miles southwest of Ciudad PEMEX. This well encountered a highly promising oil interval above 6,600 feet in the Eocene. According to PEMEX, reinterpretation of old seismic data and the use of sophisticated digital seismic surveying have linked the onshore and offshore structures into one long continuous trend.[29]

In the Reforma area, PEMEX reported a strike late in August at Artesa, about seven miles southwest of Sitio Grande. The well penetrated an oil zone of 1,650 feet in fractured Upper Cretaceous limestones and tested 5,000 barrels per day of 27 degree gravity oil, with a gas-oil ratio of 220:1. Development drilling had also indicated that the large Samaria-Iride-Cunduacan structural complex is a single field.

There had been indications that the southern limit of the Reforma trend had been reached at Sabancuy, a formation water invaded structure discovered early in the exploration program. Additional seismic work, however, revealed several large structures north of a massive regional fault bisecting the area south of Sabancuy. Subsequent drilling has proven three of these structures to be prolific producers of gas condensate. The fields, Giralda, Copano, and Sunuapa have extended the Reforma trend about 20 miles to the south.[30]

The western boundary of the oil province has also been pushed almost 20 miles to the west by the discovery of the Paredon field, associated with a major salt dome. Other structures have been mapped in the area and drilling is continuing.

As production continues, the Reforma reservoirs have been found to be undersaturated with faster than normal pressure decline in their early production life. Pressures then tend to stabilize as the reservoirs are pulled closer to their saturation points and the natural water drive becomes evident.[31] There appears to be total communication, both vertical and horizontal, and a 46 percent recovery factor is expected with waterflooding.[32]

The Reforma fields will require the injection of two or more barrels of water for each barrel of oil removed. The water flood at Sitio Grande has been activated. PEMEX expects to inject one million barrels of water per day into the Samaria-Iride-Cunduacan field, with about 40 injection wells averaging 25,000 barrels of water per day each.[33]

Not all Reforma fields, however, should be water flooded. Those located east and west of the central trend contain either gas and condensate or volatile oil with very high gas/oil ratios. In these fields, gas repressuring may be preferred.[34]

The gas/oil ratios in the central Reforma fields average just over 1,000:1 (Sitio Grande, Cactus, Samaria-Iride-Cunduacan, Rio Nuevo, and Nispero). At the end of 1977, 117 Reforma wells in those fields were producing 660,761 barrels of oil per day and 835 million cubic feet of associated gas per day. Most of the gas was being utilized, but

[28] Franco, Alvaro. Giant New Trend Balloons S.E. Mexico's Oil Potential; The Oil and Gas Journal, September 19, 1977, p. 81.
[29] Ibid., p. 83.
[30] Ibid.
[31] Ibid.
[32] Ibid.
[33] Ibid., p. 84.
[34] Ibid.

some was flared. During the first quarter of 1978 the entire Reforma area was producing nearly one million barrels of oil per day.[35]

TABLE 3.—PARTIAL LIST OF THE OIL PRODUCING FIELDS IN THE CHIAPAS-TABASCO (REFORMA) PROVINCE

Name of field, discovery date	Depth (feet)	Number of wells: Flow	Pump	Gas lift	Shut in	Production in barrels: Daily average, 1st 6 mo, 1977	Total cumulative, July 1, 1977	API gravity
Chiapas-Tabasco (Reforma):								
Ayapa, 1973	8,200	3				1,604	3,063,507	38
Blasillo, 1967	7,216	16		12		5,396	6,247,813	40
Cactus, 1972	12,333	22				87,142	87,637,010	41
Caracolillo, 1969	11,480	5				698	2,952,809	28
Carrizo, 1962	4,820	1		6		1,050	8,140,757	25
Castarrical, 1967	10,086	1		28		4,585	29,452,906	34
Cino Pdtes., 1960	6,862	24		79		17,625	209,234,428	35
Cunduacan, 1974	13,442	20				141,468	64,935,482	32
El Golpe, 1953	8,836	8		47		9,498	57,060,760	35
Iride, 1974	14,596	3				15,171	9,135,898	28
La Venta, 1954	4,730	5	1	36		4,523	51,820,171	41
Magallanes, 1957	4,240	11	1	109		8,297	110,329,921	27
Mecoacan, 1958	7,110	5				3,705	32,323,272	24
Nispero, 1974	12,993	9				20,788	10,057,219	41
Ogarrio, 1957	5,790	35		53		14,259	104,715,875	38
Otates, 1965	7,469	7		6		2,944	19,835,345	39
Rio Nuevo, 1975	15,000	2				4,051	1,659,409	35
Rodador, 1971	11,398	5		9		1,174	1,290,431	26
Samaria, 1973	14,209	36				287,515	205,207,797	31
San Ramon, 1967	9,883	8		31		8,290	37,699,505	30
Santa Ana, 1959	9,517			3		120	30,024,107	29
Santuario, 1966	9,617	10		7		7,781	18,059,326	37
Sitio Grande, 1972	13,766	19				42,162	86,095,117	35
Tintal, 1968	5,904	5				472	2,842,369	22
Tupilco, 1959	9,685	6		26		7,296	34,973,149	27

Source: Oil and Gas Journal, Dec. 26, 1977.

BAJA CALIFORNIA PENINSULA

The Purisima-Iray and Sebastion Vizcaino basins of lower California are being explored. About 15 wells have been drilled and gas has been discovered in the Baja California peninsula, about 400 miles southeast of Tijuana. The discovery well is located 28 miles southeast of Guerrero Negro. A drilling platform is planned for the Vizcaino Bay and a series of offshore test wells will be drilled. The Bombas well, which discovered the gas, indicated the presence of hydrocarbons in Baja California Sur state. However, the find has no commercial value until defined by further drilling.[36]

[35] Mexico's Combined Reserves Hit 16 Billion Barrels. The Oil and Gas Journal, April 17, 1978.
[36] PEMEX Director General Reports on Mexico's Outlook. Ocean Industry, May 1978. pp. 42–44.

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